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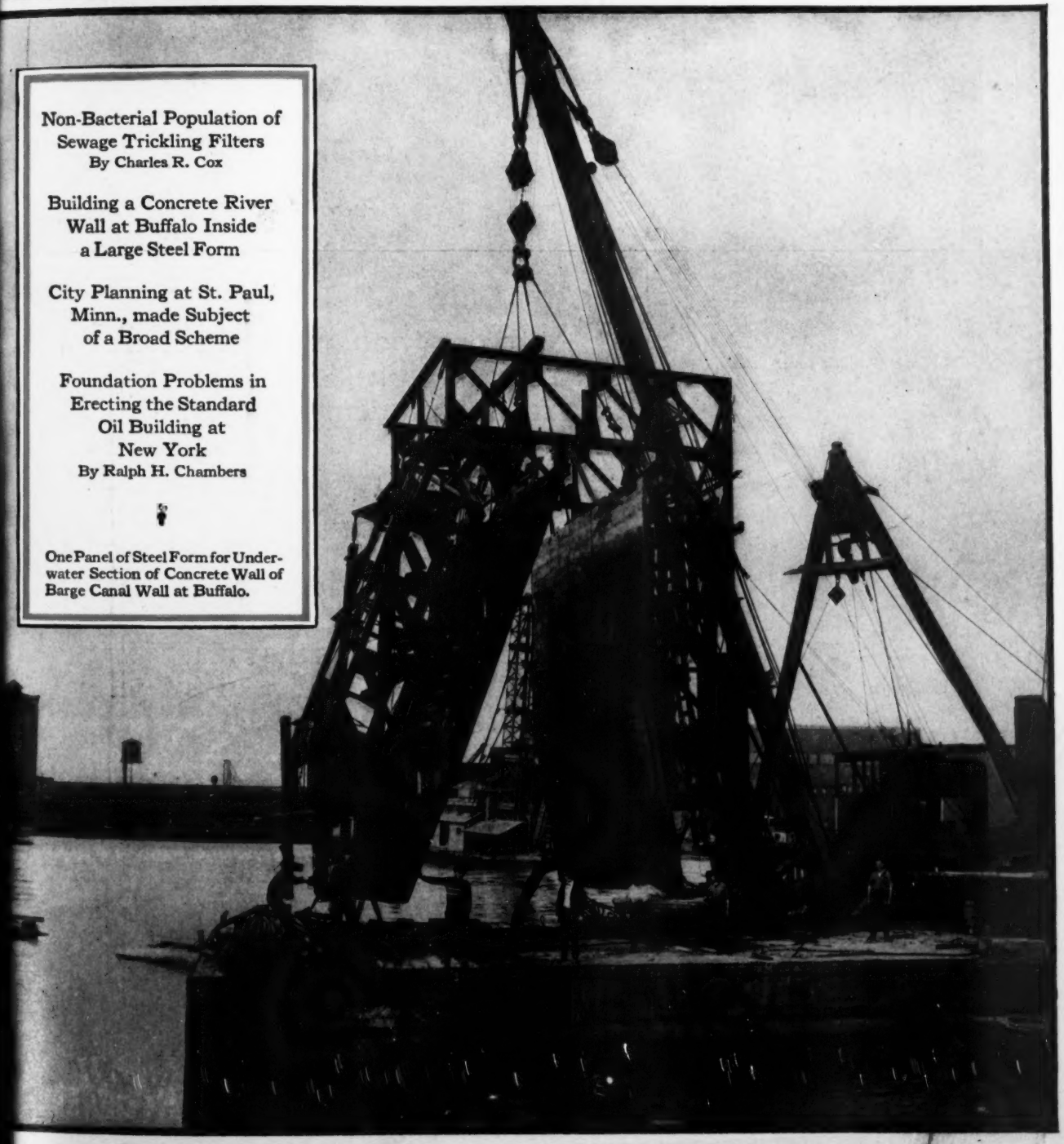
Non-Bacterial Population of Sewage Trickling Filters
By Charles R. Cox

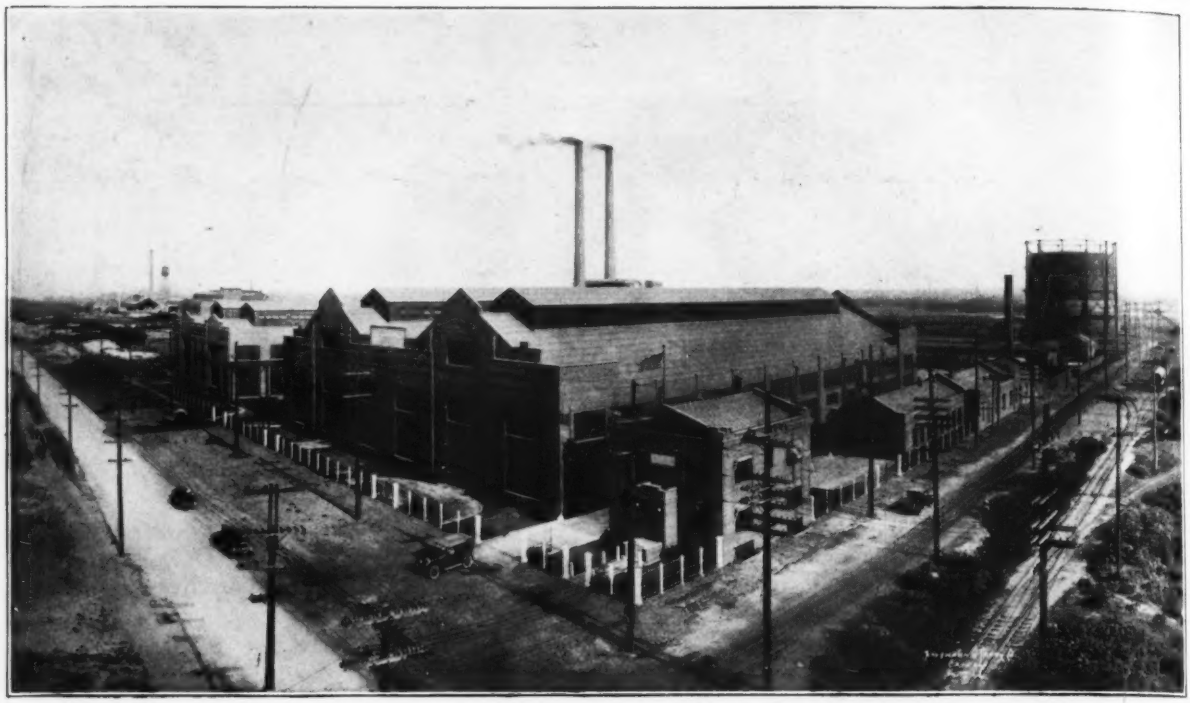
Building a Concrete River Wall at Buffalo Inside a Large Steel Form

City Planning at St. Paul, Minn., made Subject of a Broad Scheme

Foundation Problems in Erecting the Standard Oil Building at New York
By Ralph H. Chambers



One Panel of Steel Form for Underwater Section of Concrete Wall of Barge Canal Wall at Buffalo.



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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Defeated by Public Opinion

SELDOM has there been a more striking example of the force of public opinion than in the capitulation of the railroad brotherhoods last week. The public not only expressed its thorough disapproval of the strike, but that disapproval backed up the railroads and public officials in their plans for meeting the emergency. As Mr. Sheppard, president of the Order of Railway conductors put it, the opposition of the public and the Administration made it plain that the brotherhoods could not obtain their "objectives."

Working Rules Paramount

BECAUSE the Labor Board has agreed to consider all current working rule disagreements before taking up any new wage reductions, there has been a too wide-spread feeling that the brotherhoods have once more in effect won what they set out for. The fact is that the working agreements are more important than the wage scales. The cost of running the railways, which after all is what must be made less if all of us are to prosper, can be reduced by a rational revision of the working rules much more quickly and justly than by any straight wage reduction. If the Labor Board approaches these working rules with a fair mind and with a judicious consideration of what they mean in operating costs, its decision in their settlement will make the matter of base wage scales of secondary importance.

Hydraulic Dam Cores

IN THE light of the observations on the slope washout at the Englewood dam reported in the news columns it seems necessary to revise some current notions on hydraulic dam construction. The essential question has been whether a water-deposited puddle core consolidates rapidly or remains semi-fluid for a time. Much has been said concerning this question. The discussions, with its background of the large-scale accidents at Necaxa and Calaveras, has tended to cause doubt as to the advisability of using what is certainly the cheapest, and many think the best, method of building earth dams, namely the hydraulic fill method. But the facts of the Englewood core exposure make it plainly evident that a hydraulic core may be so built as to be solid even up to the top layers, just deposited. The section of the dam in which the washout occurred had been built up at much more rapid rate than the rest, because it was the closure of the gap at a temporary spillway maintained last season; yet consolidation, or perhaps we may say precipitation of the core silt was so prompt that the much-discussed semi-fluid zone was not 80 ft. deep, nor even 20 ft., but was actually non-existent. Moreover, the core mass laid bare proved to be not merely a solid substance but a tough substance, one possessing distinct structural value. These facts clarify effectively a field in which doubts have had a harmful influence. The same facts, it is said, have been revealed in other aspects on various earlier experiences in the Miami dam work. It is to be hoped that these will soon be laid before the profession in full.

Joint Committee Report Not Final

ALTHOUGH the progress report rendered last June by the Joint Committee on Concrete and Reinforced Concrete was expressly labeled "tentative" there are a number of engineers who are disposed to use it as a finished document. Such is the finality printer's ink confers. The committee took this chance when it presented a unanimous report but there seemed to be no other way in which prospective specification could be gotten before the thousands of members of the constituent societies. It is only fair to the committee to say that there was by no means agreement on all of the provisions of the report but that expediency pointed to a unanimous acceptance of the preliminary draft. Criticism would thereby become more concentrated and final acceptance made more easy. This criticism will have its first voice at a three-day meeting proposed by the American Society of Civil Engineers in December. The other societies will follow with similar meetings, and until these meetings are reported and the basis of the opposition revealed no one should assume any finality to the provisions of the specifications.

Improvement of Plant Railways

POSSIBILITIES of economy in the operation of the industrial railway systems at large manufacturing plants are suggested by the recent paper on electric operation of the railways of steel plants by R. B. Gerhardt, abstracted in *Engineering News-Record*, Oct. 20, p. 652. As a rule such a plant railway is apt to receive little attention as to cost, being regarded as a minor expense in the operation of the plant. Consequently there are unsystematic track layouts, inadequate maintenance, inconvenient service and high but unknown or unrecognized operating costs. It is probable, then, that material economies may be effected in the construction and operation of many railways of this class, irrespective of a change in traction. It is of particular interest to note that although the third-rail contact system is usually considered undesirable for yard service, Mr. Gerhardt regards it as entirely practicable. In fact, it appears to be necessary, in order to meet a certain condition in steel plants. But as this condition is not universal, most plants would be free to compare the two systems on their merits. As decided economy in favor of electric operation is indicated by the paper, it would be of value to be able to check against the author's views the actual results of an electrified plant railway. They would be of much value, too, to those having to deal with plant design and operation.

San Francisco Bay Bridge

THERE has never been any consolidation of cities on San Francisco Bay. Oakland, Richmond, Berkeley, Alameda, San Mateo and others are independent municipalities, grouped around a central city whose area is only 46.4 sq. miles. San Francisco is like New York City before the five boroughs were united to form one municipality. The last census figures show the San Francisco metropolitan area to have a population of approximately 1,000,000 but means of intercommunication between the city and the suburban districts are not good. The air line distance between the San Francisco and Oakland city halls is only 8½ miles, but by rail or highway it is nearly 90 miles. The direct route involves a water trip of 20 minutes, besides a street car ride in both cities. Via the auto ferry route, the trip is still longer, requiring 40 minutes at best. Because of this long trip and delays due to congestion, the automobile traffic has been only nominal. The automobile ferry operated by the Southern Pacific Co. handled an average of 1,667 pleasure cars per day during 1920. This might be considered a large number for a city of the same size in another part of the country, but California has more automobiles, on a per capita basis, than any other state—one for every 6.2 persons in 1919. On a Sunday or a holiday, as many as 30,000 pleasure cars have been counted leaving San Francisco over the one well-paved highway "down peninsula."

It is this tendency toward much auto travel that launched the present campaign for a transbay bridge. The commuters' desire for something better than the present passenger ferry service, of course, increased popular interest in the bridge project, but so far as the time element is concerned it is doubtful if the running time of interurban trains over the majority of the proposed bridge routes would materially decrease the time between terminals. It may be, rather, that the most satisfactory service for the regular commuter, within the reach of economic investment, would be gained by building a viaduct from the Oakland side to Goat Island, thereby reducing the ferry trip from 2.85 to 1.5 mi. But putting a roadway for vehicles on that viaduct and using auto ferries would be no means satisfy the automobilist. In California, at least, experience with auto ferries is that peak loads are so great that it is not economical to maintain the equipment necessary for adequate service at such times. For these reasons a distinction should be made between the service the commuter wants, that is, the quickest means of reaching destination, and that which the automobilist insists upon, a continuous through route. To the automobilist it will not matter that the through route is a little longer than the air line distance, but he will in nowise be content with the interrupted travel of a ferry.

Thus if a crossing for automobiles can be provided at considerably less than the cost of a structure to serve both vehicular and rail travel, then the additional cost of a railroad bridge does not seem to be justified at present. The proponents of crossings designed to serve all kinds of traffic will not agree with this view. In fact, it has already been charged that to oppose a "road and rail" crossing is to lack confidence in the future of the city and to place limitation upon its growth. Quite the contrary is true. San Francisco Bay is destined to have many crossings and the present question is merely that of deciding on the type and location of the one which should be built first.

The A. S. M. I. Convention

IN ANY engineering society whose field covers so wide a range as does that of the American Society for Municipal Improvements, which held its twenty-seventh annual convention at Baltimore last week, as reported in the news columns of this issue, the program of technical papers and committee reports must necessarily be comprehensive if all specialties are to be treated. It is questionable, however, whether the maximum of service is accomplished by attempting to dispose of any such volume of material as was scheduled at Baltimore. The program listed no less than 35 technical papers and 37 committee reports—a total of 72 addresses—to be disposed of in six sessions averaging 3 hours each, or a total of 18 hours.

If such a program is to be completed, it is obvious that an average time limit of 15 min. must be allotted to each paper or report, assuming they follow one another without interruption. On this basis, however, no time is available for discussion, admittedly one of the most important features of any gathering of engineers. Certainly one-third of the time of the technical sessions is not too much to give to discussion from the floor, especially if the membership present, representing a country-wide experience of many years in all branches of municipal engineering, is to give expression to details of practice and new developments of timely value. If, therefore, we deduct one-third from the total of 18 hours assigned to technical subjects, we would have 12 hours in which to dispose of 72 addresses, or an average of 10 min. for each paper. Any one who has been an attendant at engineering society meetings knows the futility of allowing as little time as 10 min. for the average paper or report; three times this amount would be nearer the actual requirements.

If some analysis of this sort had been made, it is doubtful whether the Baltimore program would have been so heavily overloaded as was the case. The result, of course, was an almost total elimination of discussion. In the face of this situation, however, the chair, throughout the four-day meeting, never once strove to relieve the tediousness of most of the sessions by imposing any time limit on any speaker. The incoming administration of the society will have an opportunity of exercising to a greater degree than was evident at this year's convention, businesslike methods in scheduling and actually conducting the technical program.

The fault noted is not confined to the American Society for Municipal Improvements, but that organization has been, for years, a consistent offender. Far more valuable than an attempt to pile up the largest possible volume of technical papers and reports would be an effort to inquire into what new developments had taken place in the various engineering specialties during the year, select men competent to present the chief points of interest, and request others to start discussion in the hope of bringing out, at the meeting, details of procedure which others have found useful.

Then, too, there is the important point of exercising discrimination in the placing of papers and reports on the program so that the new and important developments may be accorded more prominence than merely routine matters. Lengthy general descriptions of local engineering works, representing nothing but standard practice, should be curtailed and time devoted to what the year has brought out in methods, materials, or equipment that make for progress.

To be of maximum value to those who attend it, an engineering convention must receive a considerable amount of advance planning by men with an appreciation of relative values, and a generous amount of time should be allotted to discussion from the floor.

Politics or Engineerin

SOME of the engineers who wrote the report on the Narrows tunnel for the New York City Board of Estimate object to our editorial comment on that report last week. They contend that this tunnel was authorized by the same legislature and governor as authorized the Port Authority and that blame for ignoring that Authority lies at Albany. They feel that our criticism implies a political bias to their report.

We refuse to consider the case of the Port of New York a political one; its future is so bound up in the life of the whole nation that it presents one of the foremost economic problems of the day. Both from an economic and engineering standpoint the port must be considered as a geographical unit, which means that it must either be in the joint control of the two states in which it lies or it must pass under national jurisdiction. The former solution has been initiated, but the City of New York—and by that we do not mean the mayor or the Board of Estimate or any of the so-called political elements alone, but also the real estate interests and most of the business bodies—have fought the merger of the port interests from start to finish. That is the reason why any report to a city body which ignores the Port Authority appears to be merely a phase of the same opposition.

There is no quarrel with the engineering features of the report—that was made plain in last week's comment—in fact, the figures and deductions are more concise and complete than we have seen in any similar analysis but we insist that the proprieties would have been better served by some reference to the Port Authority's report or activities. That Authority has been established; New York City has its rights and privileges guarded in the future actions of the Authority. A proper sympathy with the joint scheme of control would seem to require an acknowledgment of the rôle the Authority will play in the development of the port through the proposed tunnel and belt line. Would the engineers, for instance, have recommended elaborate changes in channel deepening or location without reference to the War Department's control or approval? And yet in justification of an interborough tunnel scheme they emphasize the value to the port of a new railroad in the neighboring state and object when it is suggested that they might have accorded some recognition to an interstate body that has been formed to control just such a railroad.

The conflict between the city and the interstate idea has been so acrid that to disregard it even in an engineering report is to throw the weight of those making the report against the joint port idea. To criticise such an omission is not to ascribe sinister political motives to the engineers. Their offense, if any, is not positive but negative and is serious in that it may be taken as indicating a state of mind in the city of New York which does not augur well for the joint port idea. The Port Authority itself is by no means blameless; it has shown little disposition to concede anything or explain anything to the city authorities. Both city and interstate body need instruction in the art of compromise.

Lessons of the Crisis

THERE are various lessons to be learned from last week's crisis—one of preparation and the other of the folly of flying in the face of a policy that has solid support. Of preparation, the lesson can be put in the old adage, "In time of peace prepare for war." Public opinion—combined with efforts to run the roads—would have defeated the strike after it had come. But the victory before the battle was due to the energetic preparations by the railways and public officials to meet the situation. Many railroad and public officers believed even at the announcement of the strike that it would not occur. Nevertheless they did not remain idle. They worked under the theory that it would come. The railroads recruited new forces. Public officials made censuses of food and fuel supplies and organized trucking transportation. To them there was no other thought, as far as their actions were concerned, than that the war would come. Possibly we are not clear now of a railroad stoppage, and that eventually the brotherhoods will make the test. Should that occur the public will be several laps ahead in the lesson of last week, "In time of peace prepare for war."

On the brotherhoods' side we hope that they have learned the lesson that it is futile to work against a policy that has practically universal public approval. Just now the public favors price reduction. Particularly is it demanding lower railway rates. Furthermore, it is intolerant of efforts whereby one element of the community tries to maintain an advantage over the others. The farmers, the salaried workers and large groups of manual workers, both organized as well as unorganized, have suffered heavy pay cuts.

When it is appreciated that the support of these classes was absolutely necessary to the brotherhoods if they were to win, the absurdity of the proposed strike rises to the height of the ridiculous. In effect the brotherhoods were saying, "We know that your pay has been cut, but nevertheless we want you to go through the inconvenience of a great railroad strike and see your mines and factories close so that we may not have our pay reduced." It was a fine display of lack of good sense and generalship.

Not only the railroad brotherhoods but the mine workers as well need to realize the futility of antagonizing the whole public. The latter are preparing for a big strike on April 1 next; at least they refuse now to surrender the strike weapon by agreeing to arbitration in a new wage agreement, although the operators are ready to arbitrate. All those with the best information believe that the strike is almost certain. The issues are bound after a month or two to get into the public prints and the public will have an opportunity to prepare itself well in advance of the difficulty. Without attempting now to discuss the merits of the case it is apparent that the miners have lost the first engagement in refusing to agree to arbitration. It is also certain that the public is going to be ranged on the side that will tend to bring a reduction in price of coal. Coal prices are more galling to the individual than railroad rates. These factors must be taken into consideration by the mine workers or they are likely to find themselves next spring in the position the unions were in last week.

In any event the public is far stronger today than it was last week in meeting issues of that sort. If it backs up unanimous views by vigorous preparation it can save itself the sufferings inevitable in general strikes.

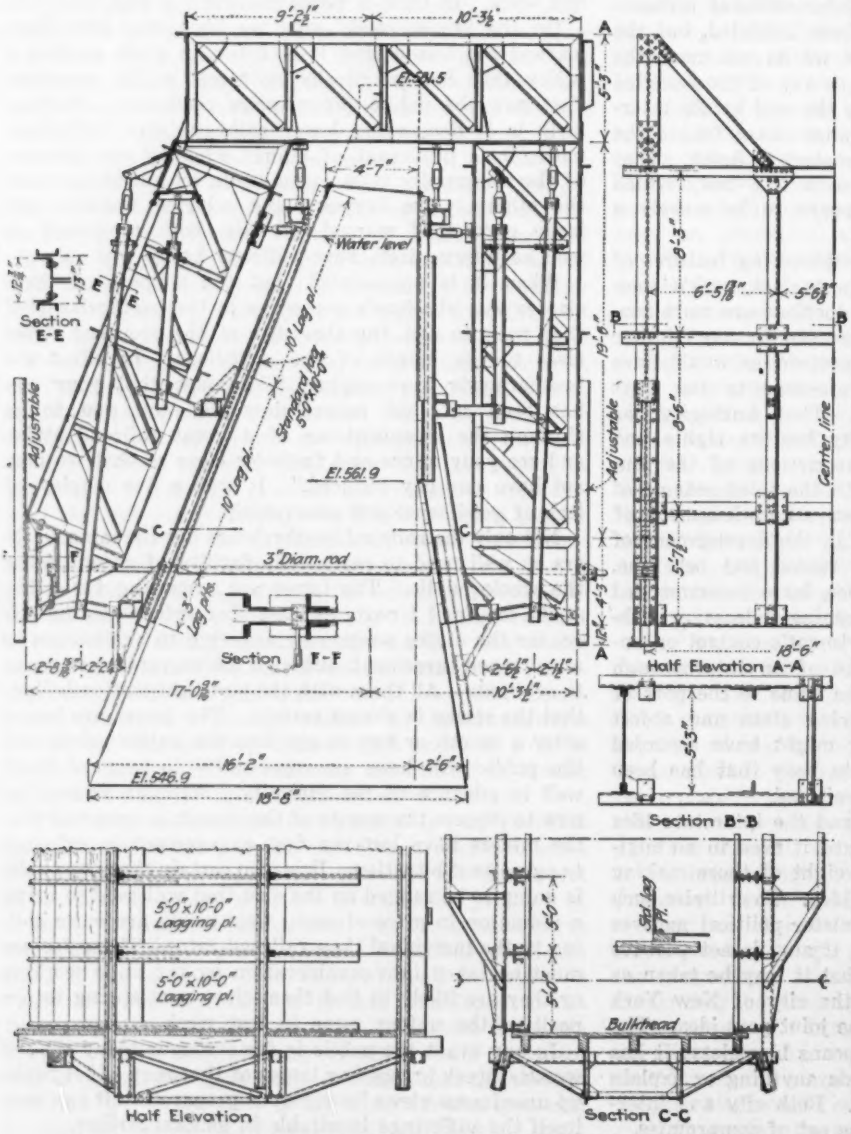
Concrete River Wall Poured Inside Large Steel Form

In Building Ohio Basin Terminal of Barge Canal at Buffalo Under Water Concrete Placed True to Line and Grade by Flexible System of Forms

HEAVY steel forms in units 40 ft. high and 20 ft. long are being used in the construction of the concrete dock walls of the Ohio Basin at Buffalo, N. Y., for the New York State Barge Canal. The forms were adopted for underwater concrete work after careful consideration of the relative cost and efficiency of the usual cofferdam method. While the investment in the steel forms is greater, it is expected that there will be a material saving due to the speed that can be made by the adopted method.

The major part of the work at Ohio Basin completed up to 1920 consisted of the entrance retaining walls founded on rock and built inside of cofferdam and the dredging of the basin to a depth of 20 ft. This work was done partly by the Walsh Construction Co. until suspended by war conditions and then taken over by the state authorities under the Walters Act until suspension for lack of funds. In 1920, proposals for constructing certain portions of the dock wall around the Ohio Basin were invited and the work subsequently let to the Great Lakes Dredge & Dock Co., Buffalo, N. Y.

The principal part of the present construction of this terminal consists of building a concrete gravity wall 1,550 ft. long and founded on the rock at elevations from 21 to 28 ft. below normal water, the complete wall being from 28 to 35 ft. high. The original proposed section had a vertical harbor face of 19.6 ft., then battered 6 on 1 to bedrock. The back had a top batter followed by offset steps. The lower section of the dock wall is built of third class concrete made of 1 part cement, 3 parts sand and 6 parts crushed stone or gravel. The upper section is built of second class concrete made of 1 part cement, 2½ parts sand and 5 parts crushed stone or gravel.

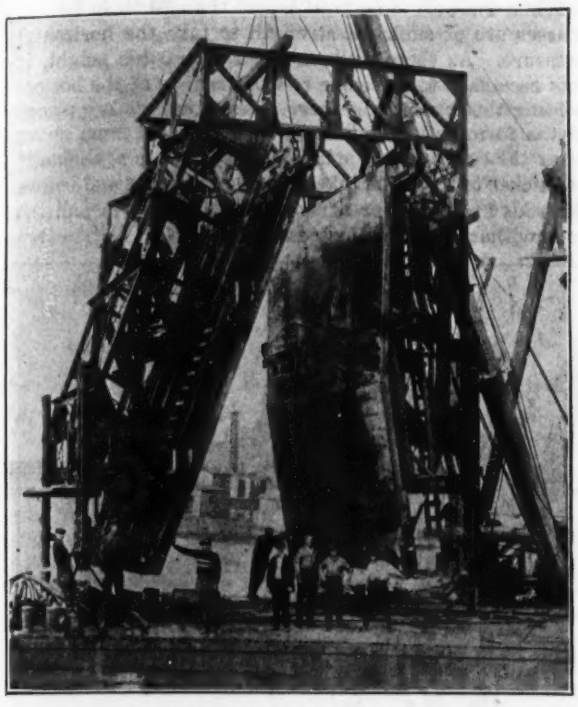


DETAILS OF STEEL FORMS USED ON BUFFALO BARGE CANAL WALL

Under the specifications the contractor, if he so desires, is allowed to place concrete under water to El. 561.9, which is 12 ft. below mean water surface. Concrete so placed shall have added thereto one extra bag of cement per cubic yard of concrete, and shall be placed by tremie or by any other method which may be acceptable to the engineer. All concrete above El. 561.9 shall be placed in dry. Permission was granted the contractor to build this wall by placing concrete under water.

Departing from the usual method of building submerged gravity walls inside cofferdam the Great Lakes Dredge & Dock Co. decided to develop a form which could be made to fit the variations in the rock surface, and could be lifted as a unit, and used continuously without being in any way destroyed or rebuilt except in so far as it was necessary to make the changes in the bottom to fit the variations in the rock. Such a form was designed and constructed by the Blaw-Knox Co. of Pittsburgh.

The form consists of a rigid frame made up of trusses rigidly braced in the vertical and horizontal direction and built to enclose the outline of the dock wall. From this frame the form for the front and back is suspended and supported by means of screw jacks and

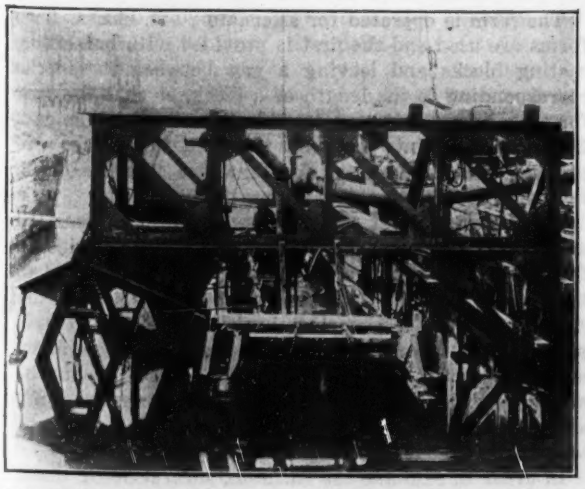


STEEL DOCK WALL FORM BEFORE BEING DROPPED OVERBOARD

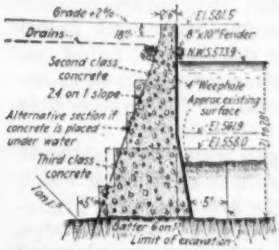
toggle arms in such a manner that the forms can be set exactly to the desired shape and dimension of the wall and afterwards, when the form has been filled and the concrete sets, released from the concrete from above without the help of a diver, and moved.

The general design of the trusses and the front and back form suspended from the trusses is shown in the views and drawings. The bulkheads for each end are made so that they can be either removed separately or handled with the form. They are held to the form by means of lugs riveted to the ends of the steel wales on the forms, into which wales the trusses of the bulkhead fit so that when the bulkheads are placed and the concrete poured the pressure on the bulkheads is transmitted into the longitudinal wales of the forms.

One of the views shows in larger detail the turn-



FORM IN PLACE—ROCK SURFACE BEING CLEANED WITH CENTRIFUGAL PUMP

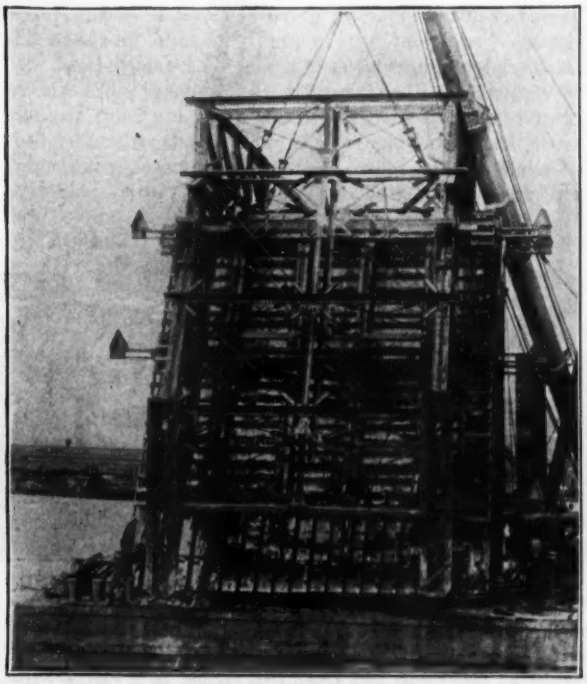


SECTION OF CONCRETE WALL

buckles and jacks which suspend the form from the frame by means of which the form can be set to exact elevation in the water and adjusted horizontally in relation to the trusses until the desired dimensions are obtained.

When submerged the form rests on four adjustable posts, one at each corner of the frame. These posts are adjustable in a vertical direction by means of a series of holes which bolt up to the frame or where quicker adjustment is needed by means of screw jacks. These corner posts are set at the right elevation while the form is out of water.

The correct elevation of the corner post is obtained by sounding the rock surface where the form is to be placed, using a specially built sounding raft, 60 ft. long and 30 ft. wide. This is built of 12 x 12-in. longitudinal, end and intermediate cross timbers, covered by 3 x 6-in.



HEAD-ON VIEW OF STEEL FORM

plank, spaced with 6-in. horizontal intervals, through which the soundings are taken with a wooden sounding pole shod with a steel point. Four steel pipes, 4 in. in diameter are used to steady the raft. These slide up and down within a 5-in. pipe, which projects several feet above and below the deck. In other words, these larger pipes slide up and down the outside of the smaller, when the raft rises and falls with the changing water level. A wooden staff gage is attached to the smaller pipe, which is adjusted to give elevations above tide water corresponding to the plans and profiles. The sounding raft is further steadied by four lines leading diagonally to anchors.

A fixed water opening for base line sounding is used, which corresponds to the face line of the dock wall, which is established by a point on shore and a distance

target. After the sounding raft is in exact position soundings are taken both longitudinally and transversely, which are corrected for the rise and fall of the water. Transverse soundings are then plotted on cross-section paper and carefully examined for any possible error.

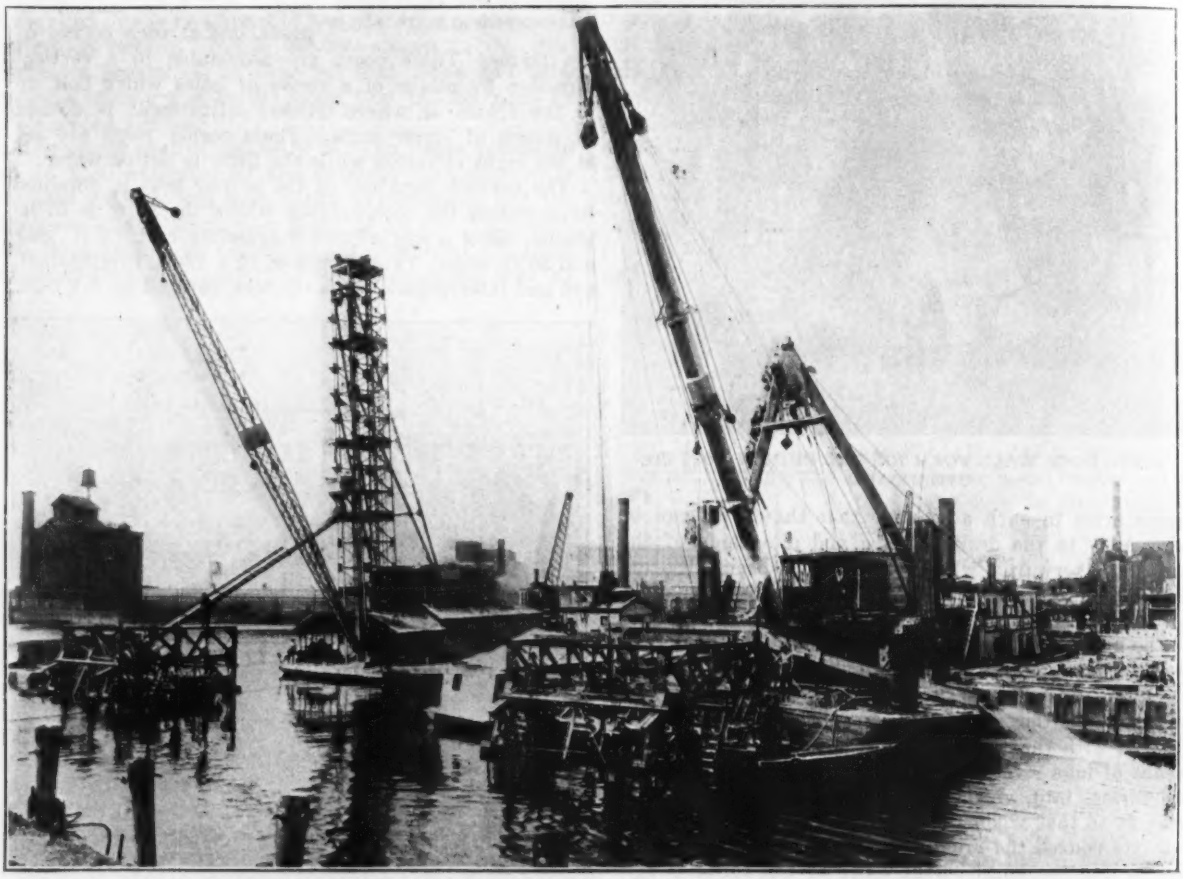
To facilitate obtaining the depth below the established water surface, a celluloid template is used, from which when correctly placed, the depths are read off a graduated edge. These depths are referred to the lower edge of the steel plates forming the side of the form. Measuring down from this edge nails are driven in the lower planks of the form and the form sawed to a curve corresponding to the bedrock surface.

When the forms were built the maximum and minimum of the bedrock was obtained and the lower timber part of the form fixed accordingly. The deepest portion of the dock wall was first poured, followed in sequence by the decreasing shallower ones. This allowed the timber to be steadily reduced, so that up to this time no shimming has been found necessary.

The forms weigh approximately 60 tons and are handled by a derrick barge of that capacity. This barge is the G. L. D. & D. Co. dipper dredge No. 8, the dipper arm being removed and a boom substituted.

After the form is set the rock surface is cleaned by a centrifugal pump operating a 12-in. suction pipe, which removes the mud loosened by water jets directed by divers. Examination of the bottom by a diver is also made before any concrete is placed.

When the wall to be built is less than 20 ft. in height, trusses are of sufficient strength to take the horizontal pressure. As these walls are more than this height, it was necessary to place one row of tie rods at the bottom holding the trusses together. These tie rods are placed in the form before it is lowered and pulled from above after the concrete has set. When a diver is available it is quicker to have him take off the nuts at one end before the rods are pulled or arrangement is made to pull the rods without a diver if necessary.



CONCRETING PLANT IN BACKGROUND. SINKING STEEL FORM IN FOREGROUND

The form is operated for alternate 20-ft. blocks. Two forms are used and the first is provided with bulkheads, casting blocks and leaving a gap between the blocks corresponding to the length of a block, so that the rear form overlapping two precast blocks will fill in the gap. Construction joints between the different blocks are provided and the recesses for same are cast in connection with the first forms carrying the bulkheads.

The Niagara River sand and gravel, which forms the aggregate for the concrete, is brought to the side of the floating mixer plant on scows and is transferred to the storage hopper placed over the mixer by a revolving crane operating a clamshell bucket. The concrete is placed in the form by means of a 2 cu.yd. bottom dump bucket operated from a steel boom supported on the mixer scow. Ordinarily 8 hours are occupied in filling a form to about one foot above water surface, the contents being about 250 cu.yd.

In order to examine the concrete, several 30-in. diam. test wells have been provided. Examination has shown

that the concrete is of excellent quality. These wells are filled before the top of the dock wall is poured—in the dry in the usual manner.

The method was conceived and designed by F. C. Hibbard, manager of the Great Lakes Dredge & Dock Co. at Buffalo, W. P. Feeley, division engineer and R. W. Reed, superintendent of the work. B. E. Failing, senior assistant engineer and Elias H. Anderson, assistant engineer, are in charge of the work for the State of New York, under the direction of Frank M. Williams, state engineer, and it was through their co-operation that the present method was made possible.

The Tulsa, Okla., Water Situation

THREE different sources of water for Tulsa, Okla., the Arkansas River, Shell Creek and Spavinaw River, each have such strong advocates that the newspapers of that city are filled with columns of comment, some of which is personal and acrimonious. However, there does not seem to be much serious disagreement as to the engineering features.

At present the Arkansas River water, filtered, is the supply. It is hard and contains such a large amount of salt at times—up to 1,500 p.p.m.—that many people do not use it for domestic purposes. In boilers it foams and encrusts badly. Contracts have recently been let to increase the filter plant capacity from 6 to 12 m.g.d. However, few people in Tulsa apparently look upon the Arkansas as the ultimate source of water for the city.

The privately developed Shell Creek supply is impounded behind a hollow dam nearing completion, storing the water from a drainage area of 20 sq. miles which in dry years would probably not furnish sufficient water for the city's present needs. The quality is good and the controversy is over the expediency of utilizing it for a few years only at the high figure and on the conditions at which it may be obtained from the owner, Charles Page. A few thousand feet of pipe line will make it available. Mr. Page has already made a contract for a 36-in. pipe line from the Shell Creek reservoir to Sand Springs. This can be extended all the way to Tulsa within four months.

Ultimately it is the unanimous opinion that an adequate supply can only be obtained through a 50-mile conduit from the Ozark Mountains. Surveys have been made of a line to the Spavinaw Creek as the most likely source. All reports indicate that the quantity and quality are satisfactory. Estimates of costs are now being made.

Recently reports have been made by water-works engineers on all of these supplies. A report by C. Arthur Brown on the present condition of the filter plant (see *Engineering News-Record*, Aug. 1, 1918, p. 221, for description of the plant) indicated that it is in good physical condition but that recent poor results, putting muddy water into the city, were due to incompetent operation. Mr. Brown found that too many baffles had been removed to keep the water moving through the mixers. The diaphragms on the filter controllers he found clogged with mud which gained entrance during the period when the plant was improperly operated. A competent operator has recently been employed and the plant is being put back into shape. It can clarify and soften the water if properly handled.

W. R. Holway, consulting engineer for the water department, has just made a report on the Spavinaw supply. He has been able to locate a gravity conduit leading the water to within five miles of the city. It must then be pumped. The water requires no treatment.

A committee of the local chapter of the American Association of Engineers, headed by Donald Witten, consulting engineer, reported fully on the Shell creek supply and recommended its use but advised keeping up the Arkansas River plant as a reserve.

The last report made public was by George G. Earl general superintendent, New Orleans Sewerage and Water Board, and Prof. Edward Bartow, University of Iowa, Iowa City, the former representing the Tulsa Water Commission and the latter the Retail Merchants Association. They recommend (1) negotiating for a temporary supply from Shell Creek; (2) expediting the additions to the filter plant; (3) pushing the Spavinaw project to completion as rapidly as possible (three years is the earliest estimated time); (4) arranging as far as possible that the three systems be mutually supporting.

The situation appears to be decidedly complicated politically. The water-works officials are apparently against the temporary supply idea but the filter plant has been allowed to get into such shape that the poor water purveyed has proved to be a powerful factor in the hands of the adherents of the temporary supply. The fancied or actual financial advantages to be gained by Mr. Page through marketing a good water supply at 10c. per 1,000 gal. for a three-year period are held up to the public by the sellers of bottled water and other interests opposed to him in as profiteering a light as possible. Now that the filters have been put back into shape the water-works officials are opposed to repudiating their own plant by admitting a temporary supply that will entail high water rates.

C. S. Younkman is chairman of the Tulsa Water Commission.

Cause of Chicago Grain Elevator Explosion

IGNITION of dust due to a fire in the drier "is by far the most probable cause" of the disastrous explosion at the Chicago & Northwestern grain elevator on March 19, according to a paper read recently before the Western Society of Engineers by David J. Price, engineer of development work for the Bureau of Chemistry, U. S. Department of Agriculture. The accident was described in *Engineering News-Record*, March 31, p. 560, and a paper by Mr. Price was published April 14, p. 634.

In the recent paper on the elevator explosion it is stated that the drier had been in operation until 1½ hours before the explosion, and that a week previously there had been a fire in the drier, supposed to have been due to the ignition of dust on the steam coil. This fire was discovered about 5 a.m. and though it was supposed to have been extinguished, it broke out again at 3 p.m., when it was necessary to run a hose line into the building. Furthermore, fires in the drier had been more or less frequent for some time, and it is assumed that this was one reason why that part of the plant was being given a thorough cleaning at the time.

Possibly dust which had lodged in the drier became ignited and during the cleaning was brushed or shaken from its lodging place, thus igniting the dust in suspension throughout the drier. The fact that the drier house was so completely destroyed is held to indicate that possibly there was an explosion with some violence in the drier before the flames spread to the basement.

Non-Bacterial Population of Sewage Trickling Filters

Review of Literature and Observations at Three Maryland Plants Indicate That Vegetable Growths Are More Harmful Than Helpful and Animal Growths Harmless or Beneficial—Methods of Control

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ALL SEWAGE trickling filters depend in part for their efficiency upon the biochemical reactions resulting from the activity of the organisms induced to grow on the filtering medium by the abundant supply of organic food material from the sewage in the presence of atmospheric oxygen. The accepted theory of the action of these filters is that the organic solids in suspension and colloidal solution are adsorbed by the gelatinous film on the stones, after which they are acted upon by the enzymes of the bacteria constituting part of the film mass. The products of these biochemical actions are usually simpler compounds, such as carbon dioxide and ammonia and stable organic matter. Thus full credit for this action is given to the bacteria bringing about the liquefaction of proteins, carbohydrates and fats, and the nitrification of the ammonia resulting from the protein degradation. There is no doubt that this view is substantially correct, but as all active trickling filter mediums contain numerous organisms other than bacteria, the complete action may not be understood unless the significance of this higher life is also considered.

Summary of Literature of the Subject

A search of available engineering and biological literature has failed to bring to light any extensive studies regarding the biochemistry of sewage disposal, other than those concerned with the well known specific actions of the bacterial enzymes mentioned above. With few exceptions, the only mention made of the higher organisms in trickling filters was when some type of growth was causing abnormal operation or nuisances. Few data were given regarding the normal flora and fauna. The following summary of the literature of the subject is given:

Fuller, in his "Sewage Disposal," states that most trickling filters contain "enormous numbers of several varieties of worms which undoubtedly play a considerable part in the elimination of organic matter." The most prevalent are the white larvæ of the small moth-like fly, Psychoda alternata, and small red worms similar to earthworms. The adult Psychoda are found in large numbers.

Metcalf and Eddy, in "American Sewerage Practice," state that excessive organic growths in England occur in winter and early spring, and that they could be removed by applying one liter of a 20 per cent solution of NaOH to each 1.6 cu.yd. of the stone filter medium. The efficiency of the filters, as measured by nitrification, was not impaired by this treatment. An experimental trickling filter at Andover, Mass., became clogged in 1906 by an amphorous jelly-like mass of bacteria and the larvæ of Psychoda (1). Both were removed by applying a strong solution of copper sulphate, or by resting the bed a few days. A pinkish growth appeared on the surface of several filters at the sewage testing station in Philadelphia (2). Resting the beds in warm dry weather destroyed the growth, which had to be washed out of the filters at times with a fire hose. As many as 115,000 gal. of water were required per acre of filter. Satisfactory results were also obtained by using hypochlorite of lime at the rate of two tons per acre, applied with the sewage through the nozzles. The most satisfactory method, however, was the continuous disinfection of the influent, which did not seem to interfere with the bacterial activity of the filters. At Worcester, Mass., growths occurred upon the advent of cold weather and disappeared during the summer. Two species of fungi caused the greatest trouble, pink to brown gelatinous colonies resembling Leptothrix, and white or grey filamentous growth resembling Leptomitus. Resting one-seventh of the filter area for one day each week served to control this growth. A rubber-like growth appeared on the Birmingham, England, filters in cold weather when fresh sewage was applied, but it disappeared when septic tank effluents were applied.

Worms Aid Digestion of Organic Matter

Metcalf and Eddy state that the very large worm population of trickling filters undoubtedly aids in the digestion of large quantities of organic matter prepared for them by bacterial action, the final material being in a granular condition more easily unloaded from the filters. Large numbers of small worms similar to earthworms were observed in the Worcester filters. Deeper in the filter they were larger in size. When the digested organic matter sloughed off the stones numerous worms were washed out with it. Psychoda larvæ and adults appeared on the Worcester filters one month after they were placed in operation. The flies seek shelter in the stones during cold weather and are seldom visible, but at times swarms flew about a building 100 yd. from the filters.

At Fitchburg, Mass., (3) during the year December, 1914, to December, 1915, it was found that growths in early spring caused the pooling of sewage on the surface of sprinkling filters. Picking the upper 6 in. of the stones solved the problem. In summer the surface was covered with a green growth, but a few inches below the surface there was the usual film and swarms of "white worms," probably larvæ. On Feb. 25, white flies appeared, and caused a nuisance until they disappeared the last of May. A small black fly then appeared and stayed until the filters were shut down in September, causing no nuisance.

Dunbar, in "Principals of Sewage Treatment," states that the red mold, Piziza omphalodes, was sometimes present on trickling filters, as well as in the upper scum of septic tanks. This scum often contains also the brown mold, Pilobolus oedipus, the earthworms, Lumbricidæ, and the larvæ of Psychoda. It may be very easy, therefore, for a trickling filter to be seeded with these organisms if septic tank effluents are applied to them.

Leo F. Rettger (4) found a pink to black fungus clogging an experimental filter at Waterbury, Conn. The growth was greatest on cloudy days on top of the stones and was at times 0.4 in. thick. He states that the red color is probably due to iron. The identification was uncertain, but it was thought that the growth was the mold, Monilla. Resting the beds for a day or longer, and then washing with a stream of water from a hose, removed the growth and prevented clogging. Two days rest in seven followed by ordinary sprinkling also sufficed.

Psychoda or Trickling Filter Fly

The trickling filter fly, Psychoda, was studied by Thomas J. Headlee (5) at the Plainfield, N. J., sewage-works in 1918. He found that the larvæ live in and consume the gelatinous film. Their number depended upon the thickness of the film, which was greater in winter and spring. The unloading of the filter in the summer reduces the food supply and in turn the number of larvæ. The presence of the flies and larvæ did not seem to influence the action of the filter, or to interfere with the society of organisms present. They were active in the filters at all seasons, but the

adults remained below the surface of the stones in cold weather. With the first advent of warm weather, and also at the latter part of summer, the flies emerged in great numbers and flew or were carried by winds at least ½ of a mile. The small size of the adults enabled them to penetrate house screens and thus create nuisances. There is no definite knowledge whether the flies may carry intestinal parasites, but no doubt it would be best to assume that they can.

The adult lays her eggs in masses on the film, the young larvæ hatching and entering the film with their breathing tube projecting into the air. The transformation to pupæ takes place in the film. The front end of the pupae cases breaks open, and the adult flies emerge. The larvæ and pupæ are most numerous in the zone between 3 to 12 in. below the surface. The adults are not strong fliers, and thus spend most of their life resting upon the underside of the upper stones and side walls of the filters. The length of the life cycle naturally depends upon the temperature. Observations show that the eggs hatch at 70 deg. F. in 32 to 48 hr., the larval stage lasting from 9 to 15 days. The pupal stage lasts 20 to 48 hr. at this temperature.

Psychoda may be controlled by submerging the filter medium for 24 hr., which is sufficient to drown the larvæ and pupæ but not to deprive the ærobic bacterial film of all its free oxygen. The film is slightly putrefactive in 36 hr. and strongly so in 48 hr. Submergence once every two weeks permits the development of numerous flies, but once every 10 days is successful in completely controlling their development. The use of chemicals to kill the larvæ was not successful because a dose sufficient to control their growth also killed the bacterial film.

The part played by the non-bacterial population of contact beds was studied to some extent in England in 1913. James Crabtree (6) states that the fauna keep the beds "open" by "working over" the film. A bed with a low fauna population had very spongy films, whereas in the normal beds this material was more granular and easily washed off. There also seemed to be a selective action on the part of the protozoa with regard to their bacterial food, the normal sewage bacteria being consumed rather than the bacteria constituting the film. This action is not significant in reducing the number of sewage organisms, because of the constant supply of fresh material in the influent.

Observations at Three Plants in Maryland

The growth on the surface of two small institutional trickling filters in Maryland, treating fresh Imhoff tank effluents, was examined in the summer of 1920. The material in both cases was a very dark green and adhered firmly to the upper stone surfaces. At the time the extent of the growth was not sufficient to cause pooling, but the depth of the green film increases apparently during the summer and fall. Unloading is greatly reduced in winter and thus the prolific summer and fall growths sometimes cause clogging in winter. At one of the plants clogging occurred when the temperature was 20 deg. F. The ashes resulting from small wood fires built to thaw some frozen nozzles quickly killed the growth. Since then a thin layer of wood ashes is spread over the filter when clogging occurs, and when the sewage is again applied a weak lye is formed, which soon kills the growth. Nothing is known of the effect of this treatment upon the bacterial film, but all life is probably killed.

Additional information upon the subject under discussion was obtained by frequent visits to a large sewage disposal plant at Back River, Maryland, during the first part of December, 1920. The disposal plant consists of the following units: Coarse bar screens, plain sedimentation (septic) and Imhoff tanks, fine screens, trickling filters, and final plain sedimentation tanks.

Following is a list of the organisms found on the top surface of the two institutional sewage trickling filters:

Maryland House of Correction July, 1920	*Maryland State Tuberculosis Sanatorium* August, 1920
Sewage very weak and fresh.....	Sewage of medium strength, but fresh.
Algae—Ulothrix	Diatoma—Navicula.
Diatoma—Melosira.	Algae—Oscillaria, Plurococcus, Tribinema.
Rotifers—Few.	Protozoa—Amoeba: Arcilla and Cysts.
	Ciliates: Paramecium, Colpidium, Chaenia.
	Worms—Few Nematodes.
	Rotifers—Few.
	Bacteria—Numerous. Numerous large spirillae.

The trickling filters have an area of 30 acres, being made up of 10 units of 3 acres each. The crushed stone, about the size of railroad ballast, is laid upon a system of underdrains to an average depth of 8.5 ft. The screened effluent of the sedimentation tanks is distributed to the filter units through a piping system and numerous spray nozzles, spaced 12 ft. apart. The nozzles are designed to deliver a square spray so that the whole filter area receives sewage. This desirable feature is not obtained in practice, however, due to partial clogging of the nozzles. There are portions of the beds, therefore, which do not receive sewage, at least at the surface, and any growth on the beds, induced by the food material in the sewage, is usually lacking in these areas. The probability is that the sprays cover about 80 to 90 per cent of the total area ordinarily. The flow of sewage to each bed is controlled by a gate valve and a motor-driven butterfly valve, which revolves once in about 8 minutes. The rate of flow is thus changed every 4 minutes from minimum to maximum. The gradual change in the rate of flow produces a corresponding change in the spread of the spray; thus every portion of the beds reached receives a dosage of sewage for only a few seconds at a time. The operation of the various beds is controlled by the specific, hand-operated gate valves. The length of filter runs may be varied at will, therefore, and advantage is taken of this to operate each bed on an independent schedule. The efficiency of the beds varies as a result, depending upon the length of time they are used. The growth on the stones also varies from bed to bed, but the difference is one of degree and not of character. Thus the Beds 1 and 2, which are used about 20 hr. per day, show the greatest growth, while the Beds 5 and 10, used only a few hours per day in times of peak flow, are practically free of growth and their efficiency is correspondingly low. The growth upon the filters is thus seen to be of great practical importance, and warrants much closer study than it has received in the past.

No Good Picture of Available Food Material

Complete chemical analyses are not made at the disposal plant as a routine procedure, and thus a satisfactory picture of the available food material in the applied sewage is not to be had. Judging from past and present records, however, it appears that the settled and screened sewage admitted to the filters is devoid of dissolved oxygen at all times and contains no nitrites or nitrates. The settleable and total suspended solids, due to previous sedimentation, are only about 30 p.p.m. and 90 p.p.m., respectively. The effluent of the filters contains on an average about 70 p.p.m. suspended matter, indicating a reduction of solids by liquefaction, etc. The total solids in the influent and effluent during 1916

averaged 644 p.p.m. and 649 p.p.m., respectively, showing no losses by the production of gases. The physical aeration of the sewage in passing through the filter is sufficient to enable the nitrifying organisms to grow and produce an average of 7.1 p.p.m. nitrates in the effluent. The aeration also supplied the sewage with sufficient free oxygen to produce a relative stability averaging 94 per cent. During the period of observation the relative stability was around 90 per cent.

Few data are available regarding the effect on the bacterial flora in the sewage by their passage through the filters. The total plain agar counts and counts of acid colonies on litmus lactose agar are available. These vary greatly, but averages for the year 1919 show a great reduction in organisms growing on both media at 37 deg. C. The counts are as follows:

	Total Count—37° C. Plain Agar	Red Colonies—37°C. Litmus Lactose Agar
Influent	700,000 per c.c.	66,000 per c.c.
Effluent	190,000 per c.c.	9,300 per c.c.

Without doubt the total number of bacteria actually present in the filter effluent is greater than in the influent, due to growth of organisms in the filter which do not develop on the above-mentioned media. The heavy reduction in the red count is of great importance, however, showing that the environment is not well suited to some typical intestinal organisms.

Controlling Environment at Back River

It will be seen from the above that the controlling environmental features in the Back River sewage trickling filters are as follows: An abundant supply of decomposing organic food material at all depths of the filters; a very limited supply of nitrates in the upper filter layers, but increasing in amount as nitrification progresses through the beds; an abundant supply of free oxygen throughout the filters but no doubt more abundant in the upper layers; a plentiful supply of water at most points in the beds; the limiting to exposure to light of all portions of beds except the upper few inches; and the temperature prevailing in the beds. The chief variables in the above list are the quality of the sewage, the temperature, and the intensity of light. The only marked variations in the growth to be expected, therefore, are slow seasonal changes, and those induced by limiting the supply of food material. Experience substantiates this conclusion. Thus, little if any change was observed in the growth of any specific part of a bed between Nov. 29 and Dec. 16, 1920, provided it was supplied with a fairly constant flow of sewage. The partial clogging of a nozzle, depriving a portion of the bed of sewage, soon resulted, however, in a great reduction in the surface growth.

The rates of flow onto the various beds differ, as mentioned before. A record is kept of the time they are used, which shows that a few beds, such as No. 1, are used about 6.5 days per week, whereas others may be used only for a few hours per day, totaling about two days per week. In order to obviate variations in the material studied, due to changes in operation, most of the observations were restricted to Bed 1. The material from this bed was compared frequently with that from the others to avoid incorrect general conclusions. The flow to Bed 1 was at the rate of 2.9 m.g.d. (24 hr.). The total sewage flow averaged 49 m.g.d. during the first part of December, 1920. The average flow for 1919 was 55 m.g.d., or 1.8 m.g. per acre per day.

The operator was questioned regarding the growth and its significance. He stated that no detailed study has ever been made of the materials, but that observation of the beds has shown that in spring the filter surface is covered with a greenish brown film, while in summer a grey growth appears. There would be numerous weeds in summer if the young plants were not pulled up. The fall and winter growth is similar to that existing during the period of observations. The filter flies are most numerous in September and early spring. The small earthworms are present at all times, but are discharged in the effluent in greatest numbers when unloading occurs in early spring, at the beginning of hot weather, and at the end of summer. The filter medium has been disturbed but little and, therefore, the vertical distribution of the various organisms is not known. Worms have been seen at least 6 ft. below the surface, however, whereas the larvae apparently remain in the upper foot or so of the filter beds. The operator stated that the new filters were "ripened" by applying sewage for about 1 hr. twice a day for a period of six weeks. In four weeks a growth was visible and by the end of six weeks the material had reached its full growth. Visible life is removed from near the surface of the beds by resting from 1½ to 3 days, and it appears again 5 to 6 days after the rested bed is placed in use in summer, and about two weeks afterwards in winter.

Seasonal Variations in Growths

The observations made at the disposal plant during the first part of December, 1920, are difficult to record, because they do not lend themselves to tabular form. Visits of inspection were made Nov. 29, Dec. 2, 7, 9, 14 and 16. The only significant visible change in the life in Bed 1 during this period was the gradual spread of a pink fungoid growth on the upper surfaces of the top stones. On Nov. 29, this growth was restricted to about one-sixth the wetted surface area, but by Dec. 16 it had spread to about one-half this area. The surface stones of Bed 1 were covered with a greenish black granular film over that portion of the area between the sprays, and thus not directly wetted. The undersides of these stones were covered with a thin slimy grey deposit, in which numerous Psychoda larvae were living. The adult Psychoda were most numerous in this portion of the bed. A few small brown spiders were also encountered. The green film proved to be practically pure cultures of Protococcus. Upon removing the upper stones it was found that this green growth was restricted to the upper layer of stones. The Psychoda adults and larvae, and the grey film were encountered for at least 12 in. below the surface. It was impossible to enter the bed deeper while it was in operation.

The area reached directly by the sprays contained a greenish grey surface growth, with pinkish patches over part of the area. Upon disturbing the surface layer it was found that the pinkish and greenish grey growths were restricted to the upper surface of the top layer of stones exposed to light. The lower stones were covered with a slimy grey film in which swarms of larvae and the small red worms were living. A few adult Psychoda were also found here. The worms were often in dense clusters several inches in diameter.

The examination of the material from the stones under a microscope disclosed that comparatively few

higher organisms and masses of bacteria constituted the films. The drier portions of the surface stones were covered with Protococcus, whereas the wetted area was covered with greenish grey slime consisting of bacteria, decomposing organic matter, Protococcus and patches of Oscillaria, and a dense surface growth of a colorless fungus, to be described later. There were no worms, larvae, or protozoa on the upper surfaces exposed to the direct action of the sprays. The pink portion of the surface growth contained the same assortment of organisms, except that the pink fungus predominated. The stone surfaces not exposed to the light or direct action of the sprays were covered with a light grey slime. This material consisted of a dense growth of the colorless fungus, larvae and worms, and masses of bacteria. There were a few filaments of Crenothrix here and there, and occasionally black patches, which proved to be Beggiatoa. A very limited number of Chlamydomonas were also seen. Numerous clusters of Epistylis were observed attached to the fungi, as were also a few Scyphidia. A few small Nematodes were also observed. At very infrequent intervals green patches were seen on the surface stones, which were shown to be composed to clusters of Conferva. The following table gives a summary of the organisms found:

LIST OF ORGANISMS FOUND ON SURFACE OF STONES IN SEWAGE TRICKLING FILTER NO. 1, BACK RIVER, NOV. 29 TO DEC. 16, 1920

Organisms	Where Found	Remarks
Algae:		
Protococcus.....	Upper stone surfaces.	Greatest development in comparatively dry areas. Chief cause of greenish color in grey growth
Oscillaria.....	Do.....	Limited in extent, but very firm growth. Could easily cause clogging if extensive.
Conferva.....	Do.....	Very limited in extent.
Protozoa:		
Chlamydomonas..	Under stones in grey film.....	Very limited in number.
Scyphidia.....	Attached to hyphia of colorless fungi.	Limited in number.
Epistylis.....	Do.....	Numerous. Probably are instrumental in reducing number of sewage bacteria.
Fungi:		
Unknown (pink)...	Upper surface of top stones.	Very firm, wrinkled growth over Protococcus. Pink by reflected light. Pale green by transmitted light. Apparently one of the Fungi Imperfecti. No fruiting bodies seen, but light green, detached spherical spores were observed in material.
Unknown (grey)...	On all surfaces of stones examined except in dry portions of area.	Commonest plant found. Was easily torn from stone surface. Complex cell structure and branch system. No fruiting bodies found.
Worms:		
Nematodes.....	In grey film on undersides of stones.	Few—Of no significance.
Chaetipoda:		
Lumbriculidae.... (earthworms)	In all portions of bed below surface receiving sewage.	Very numerous. One of the three commonest organisms found.
Insects:		
Spiders.....	In dryer portions of bed, under the surface.	Small dark brown spiders. Sluggish. Apparently catch adult Psychoda.
Psychoda.....	Do.....	Larvae numerous in portions of bed. Adult sluggish. Poor fliers. Seldom seen on surface of beds. Not observed at any distance from filters.
Schizomycetes:		
Zoogloea.....	On all stones receiving sewage.	Great masses of bacteria were seen mixed with the grey fungus on all the lower stone surfaces.
Spirilla.....	Do.....	Large sulphur bacteria were fairly numerous.
Crenothrix.....	On underside of top stones.	Limited in extent.
Beggiatoa.....	On filaments of grey fungus.	Fairly numerous.

The identification of the two mold-like fungi could not be made because of the absence of fruiting bodies on all of the numerous specimens examined. There was not time to grow cultures on artificial media. The pink growth on the upper surfaces of the top stones apparently did not grow unless exposed to light. A selection of those parts of the surface receiving the greatest flow of sewage was also characteristic of this growth. To the unaided eye the material had a pink to red color. The growth is firm, adhering to the stones so that the action of the spray does not loosen it. The surface is wrinkled, and made up of very numerous small mounds, apparently resulting from growth in bushy-like masses from many centers. The mold does not seem to interfere with the growth of the Protococci underneath. Under the microscope the material was pale green in color. The mycelia consisted of long celled filaments with few, irregularly spaced branches, having the same diameter as the parent stem. The whole mass apparently radiated from common centers, but the tree-like branched structure was lacking. Numerous spherical spores were observed, pale green in color and slightly less in diameter than the mycelia. These spores were actively developing, and produced slightly crescentic-shaped pointed cells, which developed into straight, many celled filaments, unbranched at first. This fungus probably belongs to the Mucedinaceae family of molds. Its pink color and spherical spores seem to indicate that it may be Monillia, which was found at Waterbury. Nothing could be learned in available literature regarding the morphology of Peziza omphalodes, the red fungus found by Dunbar on trickling filters in Germany. The similarity in color of this fungus and the pink one at Back River is of course insufficient evidence to warrant saying that the two are identical.

Frungs Not Identified

The colorless fungus was found to constitute the bulk of the light grey film on the stones below the surface of the filter. The material was loose and easily detached from the stones, which probably is one reason why it was so easily superseded on the upper exposed surface by the pink growth. Under the microscope the material was seen to consist of pale green to colorless filaments, with firm short cells. Dichotomous branching occurred very frequently, with the result that very perfect tree-like structures were formed. These are grouped in dense, bushy clusters, radiating from common centers. The cells are 4 or 5 of their diameters in length. The cell divisions are very complete and definite. The protoplasm is pale green to colorless, and contains numerous vacuoles and granules. The protoplasmic structure is more complex than that of the common molds. The absence of any reproductive bodies made identification impossible. One would be inclined to believe that the organism was the green algae Cladophora were it not for the apparent absence of chlorophila, and the fact that the growth occurs below the light line. The classification as an unknown fungus, therefore, has been adopted.

No attempt was made to determine the species, and in some cases even the family of a few of the organisms found, because little practical importance can be attached to these more detailed biological data. Most of the organisms were identified with the aid of the keys in Ward and Whipple's "Fresh Water Biology," and Whipple's "Microscopy of Drinking Water." Dr. Root, of the School of Hygiene of the Johns Hopkins University, kindly identified the filter flies as Psychoda.

They are small, thickly haired, moth-like flies, with comparatively large, hairy wings, which lie roof-like over the abdomen when at rest. Their description can be found in Williston's "North American Diptera."

The results of the microscopical studies of the material from the sewage disposal plant are very surprising in showing that the number of types of organisms is very limited. This finding is unlike that resulting from a study of the life in sewage polluted streams. The most significant characteristic of most of the organisms found is their attached nature. If the very limited number of Chlamydomonas are excepted, all the organisms are attached in some way to the filter medium, or are sufficiently strong to resist the washing action of the sewage. This does not apply to the bacteria and the larger sulphur spirilla, but these live for the most part in the comparatively quiescent portions of the sewage between mold mycelia, etc. The two commonest Ciliates of sewage polluted water, Paramaecium and Colpidium, were not observed at any point. The outstanding difference between the material from the larger plant and that from the other much smaller Maryland plants is the presence of fungi and the comparative absence of algae at the former. It is thought that the septic condition of the applied sewage at the large plant, or in other words the complete absence of nitrates and dissolved oxygen, accounts for this difference. As nitrification starts at or near the surface in the filters some nitrates are formed, no doubt, near enough to the surface to support the limited algae growth present. On the whole, the presence of algae would seem to be detrimental, because they are likely to cause pooling, as at the plant of the Maryland State Sanatorium. In addition, they consume as food the stable, dissolved, mineralized, organic matter, and transform this to living protoplasm, which eventually dies and adds to the undesirable albuminoid ammonia content of the effluent.

Schizomycetes Limited in Number

It is doubtful if any of the schizomycetes found, other than the very important saprophytic bacteria, are of any practical importance at the plant, because of their limited number. Sewages high in iron or hydrogen sulphide would no doubt feed much greater numbers of Crenothrix and Beggiatoa than found, and thus these organisms would then be of significance. The converting of soluble iron into the insoluble state would have little practical value, however, other than the ability to remove the insoluble iron by sedimentation in the final tanks. The physical aëration in the beds would bring about this result in any case. Hydrogen sulphide might easily be produced in sufficient quantities to cause local nuisances, and thus its conversion to sulphur by Beggiatoa would be beneficial.

The protozoa are too limited in number to be of any service in the filters. Their attached character restricts their activities to that of feeding. Large numbers of bacteria are no doubt consumed but the great removal of bacteria by the filters is probably due to physical adsorption followed by death. The beneficial effect of the "working" of the film by the motile Ciliates, as discussed by James Crabtree, is entirely lacking at the plant, because of the absence of such forms. Their presence in the filter at the Maryland House of Correction indicates that motile protozoa can maintain their existence in the environment of trickling filters as well as in contact beds, provided the applied sewage is suitable in character. The indications are, however, that the "working" effect is best accomplished by the much larger worms and larvae.

The two fungi types may be of significance in two ways: (1) In causing pooling, and (2), in the beneficial results which may be derived from enzyme digestion of the complex organic material. Pooling has never occurred as yet at the large plant, and little trouble along this line is to be expected, because of the facility of resting any particular bed. In small plants, however, trouble may be experienced such as that at Waterbury. This indicates the desirability of constructing even small trickling filters so that portions may be thrown out of service to kill off growths. It would seem that the light grey growth would not have the consistency necessary to cause pooling, but this does not apply to the pink growth.

Action of Enzymes of Fungi

There are many data in literature regarding the action of specific enzymes of certain fungi upon various kinds of organic matter. No references could be found, however, which gave detailed data covering the conditions in trickling filters. It is known, nevertheless, that most fungi secrete specific enzymes, which liquefy proteins, carbohydrates, and fats. Thus the very high fat content of a dried sewage sludge was reduced in a few months from 20 per cent by weight to nothing by the secreted lipase of fungi. The aerobic decomposition of the complex carbohydrates by analytic enzymes of fungi is common in nature, as is also the liquefaction of proteins. It is impossible to say, however, whether the two fungi-like organisms found at Back River secrete these enzymes, and, if so, whether their limited number would materially affect the large amount of organic matter passing through the filters. Considerable work would be required before any definite conclusions could be reached. The liquefying power of fungi is no doubt greatly in excess of the needs of their metabolism. This excess of the material liquefied is the measure of their usefulness in a trickling filter. The soluble matter formed and absorbed is transformed into complex protoplasm, however, which increases the load on the filter when the growth dies. In the light of present knowledge, it would seem best to consider fungoid growths as nuisances, and likely to cause pooling or, at least, reduced aëration in the beds.

Chaetopoda or Bristle-Bearing Worms

The very numerous bristle-bearing worms, or Chaetopoda, found at the large plant undoubtedly have a marked effect upon the organic matter in which they live. Like the well-known earthworms, they consume complex organic matter, which is digested and broken down in their intestines to much simpler materials. The family, Tubificidae, has become closely identified with the digestion of sewage sludge banks in polluted streams. It is safe to conclude that the Lumbriculidae found in the filter likewise consume and digest considerable organic material, although probably not as much as is claimed for the Tubificidae—amounts equal to their own weight per day. The constant passage of the forms through the organic film naturally keeps this material more porous than it otherwise would be. Aëration is thus favored, and no doubt this factor is

one of the most important effects of the presence of the higher organisms in the filters. There was no bed having a thick film and few worms at the Back River plant, so the effect of the absence of worms could not be ascertained. One would expect that the resulting film would be similar in character to the sticky spongy one observed in England by Crabtree when protozoa or other motile animals were absent. The few small Nematodes observed in the grey film are of little significance in themselves, but if numerous they could greatly aid in consuming the organic matter. It may safely be concluded, therefore, that the large worm population is beneficial to the processes going on within a trickling filter.

Only two types of insects were observed on or in the filters at the plant. Small brown spiders were seen on the underside of the upper stones of the drier portions of the beds, where the adult Psychoda were most numerous. They were evidently living on these flies, but of course did not materially reduce their number. Psychoda were very numerous. Their larvae lived in the film together with the worms, and, therefore, aided these organisms in consuming the deposited organic matter and in keeping the film "open." There have been times in the past when the adults created a nuisance on or near the beds, but the fly was not observed at any distance. It thus seems that the beneficial action of the Psychoda larvae makes this organism a valuable member of the filter population. Its growth should be aided, except where sewage trickling filters are near dwellings, and the adults are likely to be a dangerous nuisance.

CONCLUSIONS

It may be concluded from the above data that growths on sewage trickling filters are of more importance than they are usually considered to be.

Vegetable growths on such filters are likely to cause pooling trouble, which far outweighs any benefits derived from biochemical changes induced by them.

The animal population of trickling filters is either harmless or greatly beneficial to the action of the filters.

The dissolved oxygen and nitrate contents of the applied sewage are probably the controlling factors in determining the character of the growths in the filters.

Objectionable life in filters may be prevented or killed by the use of chemicals, flooding, or resting the beds. The use of chemicals is expensive, or would require special supervision to be economically feasible. Flooding is usually not possible because of the open structure of trickling filters. The resting of clogged filter beds is, therefore, the most successful way in which to restore them to a normal condition.

The desirability of being able to rest portions of the filter area indicates that all trickling filters should be constructed with several independent units. The amount of reserve area required, however, is hard to proportion without advance knowledge as to the character of the growths to be anticipated.

Acknowledgment—The writer wishes to acknowledge the aid of Dr. Raymond Salter in the preparation of this paper by his helpful criticism.

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Long Concrete Trestles to Cross Southern River Swamps

Four Bridges To Improve South Carolina Coastal Plain Transportation—Concrete-Pile Type Proves Cheapest

BY J. L. PARKER
Bridge Engineer, South Carolina Highway Department, Columbia

SOUTH CAROLINA is crossed by two large rivers, the Santee and Pee Dee, and a third, the Savannah forms the boundary between the states of South Carolina and Georgia. None of these rivers is crossed by a highway bridge within 170 miles of the sea, and they have long been barriers to the proper development of the state. Provision was recently made for a highway bridge over the Santee River at Murray's Ferry, over the Pee Dee River at Mars Bluff-Ferry, over the Wateree River at Garner's Ferry, and over the Savannah River at Augusta and Savannah. These bridges will cost about $2,200,000. The largest, the Santee River bridge, will be described briefly. It is typical of the group.

The rivers referred to above flow through the Coastal Plain for 150 to 200 miles from the sea. As with nearly all rivers in the Coastal Plain, the main channels are small, carrying all of the water only under normal conditions, the greater part of the flood water being carried through swamps several miles wide. These swamps are low, with heavy timber and undergrowth, and are subject to frequent overflows.

Located at Murray's Ferry, about 65 miles above the mouth of the river, the Santee bridge will be an impor-

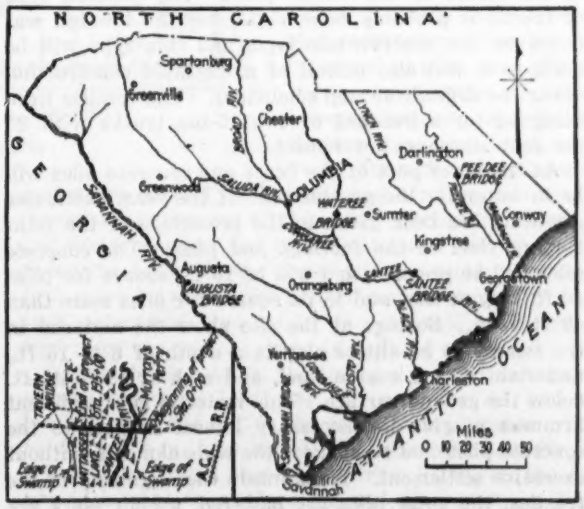


FIG. 1. RIVER CROSSING IMPROVEMENT IN SOUTH CAROLINA

tant link in the proposed Atlantic Coastal Highway. At the site the main channel is only about 330 ft. wide, and the swamp is nearly four miles wide. The flow of water is retarded to such an extent by the heavy timber and undergrowth that the extreme high water in the flood of 1908 averaged about 21 ft. deep, across the swamp, although the drainage area is only 15,000 sq.mi. In order to reduce the maintenance charges to a minimum, all structures, except the main spans, will be of reinforced concrete. The bridge will have an 18-ft. roadway, and will be above the highest known water. This width, the minimum used for bridges built by the state highway department, is believed to be ample for this country bridge, although a heavy tourist traffic should develop. As the Santee River is a navigable stream, a 63-ft. draw span is provided. The main channel crossing has one 180-ft., through steel truss swing span and two 120-ft. through steel truss fixed spans on concrete piers.

The approach trestles will have a total length of about 6,000 ft. There are seven trestles, of lengths and positions such as to provide for the most effective discharge of the flood waters. The plans provide for two types of structure, one, the pedestal type, having 36½-ft. concrete beam spans on cast-in-place bents on timber piles, the other having 24½-ft. concrete beam spans on concrete pile bents. These types of structures have been found generally to be the most economical for bridges through the low and wide swamps of the rivers of the coastal plain. The pedestal type of trestle is probably more rigid, but the low bid was based on the concrete-pile type, and this type will be used, as it will also permit of more rapid construction under the difficult swamp conditions. The trestles were designed for a live-load of two 15-ton trucks with 25 per cent allowance for impact.

As the lower part of the bents and concrete piles will be in water for the greater part of the year, particular attention has been given to the protection of the reinforcing steel in the footings and piles. The concrete piles will be pre-cast, and will be 16 in. square for piles 40 ft. long or less, and 18 in. square for piles more than 40 ft. long. Borings at the site show the material in the swamp to be silt or clay to a depth of 8 to 16 ft., underlain with a coarse sand, and rock at 18 to 40 ft. below the ground surface. This material is of sufficient firmness to give the necessary lateral support to the concrete piles and to support the embankments without excessive settlement. To maintain the alignment of the trestles, the outer piles are battered, anchor piers are provided at the center of the long trestles, and abutment piers at each end of each trestle to take up the thrust from the fills.

The embankments will be 23 ft. high, have a total length of 13,200 ft., and require 800,000 cu.yd. of earth. Material is to be taken from borrow pits outside of swamp. As no rapid currents can develop under the swamp conditions, the end slopes will run through abutment piers of the trestles and will be riprapped. Wooden railings are used on the embankments, on account of the risk of settlement causing cracking of concrete railings. On the trestles a simple and pleasing form of concrete railing, widely used in the South, will be applied. As the bridge is on tangent and it is extremely unlikely that a truck could strike a blow normal to the railing, its strength is believed to be adequate to give protection to traffic.

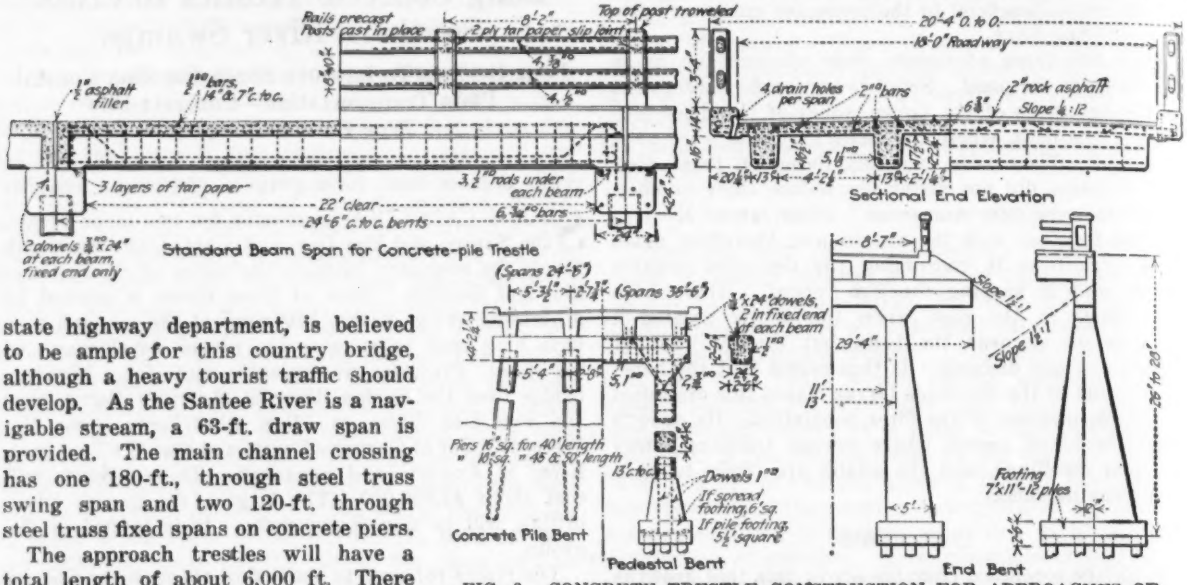

Rails precast
Posts cast in place
Top of post troweled
2 ply tar paper slip joint
20'-4" O. to O.
18'-0" Roadway
1" asphalt filler
1" ø bars, 14" & 7" c. to c.
4 drain holes per span
2" ø bars
2" rock asphalt
Slope ¼:12
3 layers of tar paper
3½" ø rods under each beam
22' clear
6-¾" ø bars
24'-6" c. to c. bents
2 dowels ¾" ø x 24" at each beam, fixed end only
Standard Beam Span for Concrete-pile Trestle
Sectional End Elevation
(Spans 24'-5")
(Spans 36'-6")
¾" x 24" dowels, 2 in fixed end of each beam
Slope 1½:1
29'-4"
Piers 16" sq. for 40' length
" 18" sq. " 45 & 50' length
13' c. to c.
Dowels 1" ø
If spread footing, 6' sq.
If pile footing, 5½' square
Footing 7' x 11'-12 piles
Concrete Pile Bent
Pedestal Bent
End Bent

FIG. 2. CONCRETE TRESTLE CONSTRUCTION FOR APPROACHES OF SANTEE RIVER BRIDGE

In order to protect the trestles from the heavy drift carried by the Santee River in flood, a strip of land 225 ft. wide is provided on the upstream side of the right of way on which the timber is to remain standing for so long as protection of the trestles is necessary.

Construction work is now under way. Contracts have been awarded to the Atlantic Bridge Co., Roanoke, Va. for the main spans, to the Simons-Mayrant Co., Charleston, S. C., for the substructure of these spans, and to the Rollin Construction Corp., New York, for the approaches. The total cost of the bridge will be about $850,000. Funds are provided by the Santee Bridge District, composed of the counties of Charleston, Williamsburg and Berkeley, and the federal government. The work is being directed by the State Highway Department, Charles H. Moorefield, chief engineer.

Local Freight in California Moves by Truck

In a recent opinion handed down by the railroad commission of California, Harley W. Brundige, president of the commission, made the following statement: "About 70 per cent of less-than-carload freight within a radius of 100 miles of San Francisco, Los Angeles and other jobbing centers, is now moved by auto trucks; on a 50-mile basis the percentage is considerably larger."

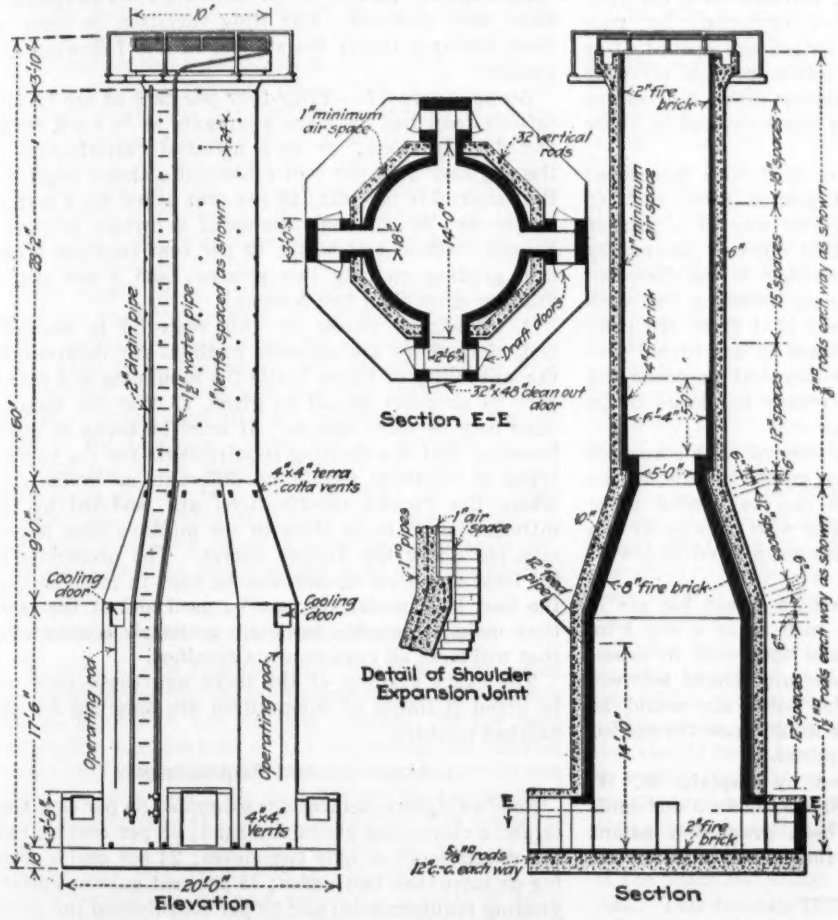
Incinerator For Mill Refuse Made Of Brick and Concrete

Air Vents and Expansion Joints Increase Life of Materials Under High Heat—Space Between Shell and Lining

AN INCINERATOR for destroying mill refuse designed for low first cost and long life has been in service at the plant of the Pacific Box Factory in San Francisco 18 months and is reported to be wholly satisfactory. It consists of a concrete shell with fire brick lining, 14 ft. in diameter at the base and 60 ft. high, built at a cost of $6,000. Thus far the capacity has not been reached by the maximum rate at which it has been possible to blow material in through the 18-in. feed pipe. As much as 400 cu.yd. of refuse have been consumed in 9 hours and it is claimed that the greater the rate of feeding the hotter the fire and hence the greater the capacity. Features of the design are the means provided for the expansion of the brick work and the arrangement of vents for cooling concrete thus increasing the life of the structure.

The outer or concrete shell was made in two pours, each pour being made in a day. The first pour carried the structure to height of 28 ft. and left reinforcing projecting for bond. This was the only joint as the second pour completed the structure to full height. Self-supporting forms of the ordinary type were built up on the inside, and outside forms were built up independently supported by scaffolding. The only connection between the two sets of forms were the tie wires run through from side to side to prevent spreading. A 1:2:4 mix was used, delivered by a hoist in the scaffold. All reinforcing was deformed steel bars tied at each intersection with No. 18 soft annealed wire. Dimensions and arrangement of reinforcing are shown in the accompanying illustration. Inside forms were removed in about four days, but outer forms were left in place as long as possible as a protection against wind and weather.

The brick lining put in after the inside forms were removed, was likewise placed in two sections, the upper section resting on a shelf in the concrete and being entirely independent of brick work below. This separation makes it possible to put an expansion joint in the brick work which is said to be the most important feature of the design. The brick of the combustion chamber can expand upward without lifting the weight of the lining above, thus preventing the overloading that tends to crush or buckle the lining and shorten its life.


10'
3'-10"
28'-2"
60'
6'-0"
17'-6"
3'-6"
18"
20'-0"
Elevation
2" drain pipe
1" water pipe
1" Vents, spaced as shown
4"x4" terra cotta vents
Cooling door
Cooling door
Operating rod
Operating rod
4"x4" Vents
1" minimum air space
32 vertical rods
14'-0"
3'-0"
18"
2'-6"
Draft doors
32"x48" clean out door
Section E-E
1" pipes
1" air space
Detail of Shoulder Expansion Joint
2" fire brick
1" minimum air space
4" fire brick
6'-4"
5'-0"
10"
12" fire brick
8" fire brick
14'-10"
5/8" rods 12" c.c. each way
2" fire brick
Section
18" spaces
16" spaces
12" spaces
6" spaces
6" spaces
12" spaces
12" spaces
6" spaces
6" spaces
12" spaces
12" spaces
6" spaces
6" spaces
12

the concave curve or corbeling-in of the brick work toward a smaller-diameter throat is said to improve the draft at the same time that it reflects the heat in such way that high temperature and excellent combustion is secured. A very small quantity of ash accumulates as the draft and high temperature are such as to reduce the residue to a minimum and to carry away a part of it as very fine particles that escape in the draft. No grate bars are used, the concrete foundation at ground level being covered only with a layer of fire brick on the flat.

A means of controlling the rate of burning and, to a certain extent, the temperature of the brick lining is provided by four 20 x 20-in. iron doors at a height of 19 ft. above ground extending through both the concrete and brick. These doors, controlled by rods running down to a convenient height are opened after the fire is well started and by admitting cold air near the top of the combustion chamber prevent excessive heating of the brick work. The inlets covered by these doors incline sharply upward.

Draft for suitable combustion conditions is secured by means of short tunnels at ground level, each of which has an indirect air entry by way of a pair of iron doors. These doors are held open as desired by ratchet latches and are set according to the direction of wind. At the outer end of these tunnels a wall with fire brick facing takes the direct heat from the combustion chamber, except in the case of one tunnel provided with a large end-door for clean-out purposes and for convenience in passing in refuse too large to be blown in through the 18-in. pipe.

The top of the incinerator is covered with screen of ½-in. mesh to catch sparks and a gutter is built in the concrete around the top which can be flooded when desired. A 1½-in. galvanized water pipe runs up to this gutter and a 2-in. drain pipe leads down from its lowest point.

In applying a design of this sort where hot air is needed for some auxiliary use, such as in a dry kiln, the concrete shell could be made octagonal in cross-section all the way up to increase air volume between shell and lining. Vents to the outer air would be omitted and a blower at the base would draw the heated air into a pipe for delivery as desired.

The incinerator was designed by Captain W. W. Breite, structural engineer of San Francisco and built by Herman Ludwig who has been granted a patent under the name of the Ludwig incinerator and hot air dry kiln.

Uncompahgre River Flood

During June floods in Uncompahgre River, Colo., exceeded any previous floods of record. On June 11 a stage of 3,900 sec.-ft. was reached and continued until June 14, when a heavy storm over the whole watershed raised the flow to between 4,300 and 4,500 sec.ft. at the upper end of the valley. Reporting on the flood in the October *Reclamation Record*, L. J. Foster, project manager, states that former seasonal flood discharges as far back as 1898, range only from 1,500 to 2,450 sec.-ft. Much damage was done to works of the U. S. Reclamation Service, private ranches and the Denver & Rio Grande tracks. At one point it required three days time with a dragline to turn the river back into its old channel by closing a 315-ft. gap in the river bank. Bundles of trees were anchored with rock baskets.

A Study of Topeka Mixed Bituminous Pavement Specifications

Practice in 46 Cities and States Analyzed—Wide Variations Noted—Desirable Mixture Suggested

By Roy M. Green
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IN ORDER to study the methods of specifying the laying of mixed asphaltic (Topeka) roads in common use in the United States requests were sent to every state highway department and the city engineers of the two principal cities in each state, asking for copies of their specifications. As a result of these requests 46 specifications were received. The wide variation in many of their features forms the subject of the following discussion:

Large Aggregate—Fifty-four per cent of the specifications described the large aggregate as "a hard, tough and durable stone," or as a material "satisfactory to the engineer"; 72 per cent contained a clause requiring the material to be clean; 20 per cent called for a certain toughness; 39 per cent demanded a certain minimum French coefficient of wear; 19 per cent required a certain grading on only two screens; and 9 per cent a grading more than two screens.

A cleanliness clause for this material is desirable and, since there are accurate methods for determining the suitability of stone, limits for toughness and resistance to abrasion should be given, so that the instructions may be more specific. It must be borne in mind, however, that the limiting requirements for the various types of mixtures should be different, as in the case where the Topeka specifications are modified by the introduction of more stone in the mixture than is permissible under the Topeka decree. The properties of the local materials should also be kept in mind so that the best local materials may be used and at the same time make it possible to obtain materials economically that will meet all requirements specified.

The exact grading of the large aggregate need not be given if limits of composition are specified for the finished mixture.

Sand Grading Requirements

Sand—Of the specifications examined 80 per cent contained a cleanliness clause for sand; 38 per cent a grading requirement on only two sieves; 24 per cent a grading on more than two sieves; 38 per cent gave no specific grading requirements; and 59 per cent limited the maximum amount of material passing the 200-mesh sieve. This limiting amount passing the 200-mesh sieve varied from 4 to 10 per cent.

Since it is possible for a fine sand to be too dirty for this type of construction a cleanliness clause is desirable. As the fine sand passing the 200-mesh sieve is not usually useful as a filler, and may be a detriment, a clause limiting its amount to not more than 10 per cent is desirable. In some cases, depending upon the nature of the sand, this limit should be reduced to 6 per cent.

It is not necessary to give the grading limits for this material, other than that passing the 200-mesh sieve, if the formula for the mixture is closely drawn so as to control the finished mixture.

Filler—Eighty-five per cent of the specfications allowed the use of either portland cement, limestone

or dolomite dust to be used as a filler; 7 per cent did not mention the filler in any way; and 57 per cent placed a minimum amount passing the 200-mesh sieve for this material.

Since portland cement, limestone and dolomite dust have been successfully used as a filler it is desirable to allow the use of any one of them. A minimum amount of material passing the 200-mesh sieve is desirable, so that a certain definite proportion will be sufficiently fine to be classified as filler. A limit on the maximum size of the filler should also be specified.

Asphalt Cement—Of the specifications examined 55 per cent were of the blanket type, that is, they described the oil asphalts and natural asphalt cements by one and the same group of test limits; 36 per cent were of the alternate types, that is, for purposes of description the natural asphalt cements were separated from the oil asphalt cements; 9 per cent were closed to all except oil asphalts. Forty-five per cent were modeled after the asphalt cement requirements of the 1914 sheet asphalt specifications of the American Society of Municipal Improvements; 33 per cent were modeled after the specifications suggested by the U. S. Bureau of Public Roads; and 7 per cent allowed the use of a tar as well as an asphalt cement.

Since equally good results may be obtained by the use of any asphalt cement of recognized standard no engineer is justified in drawing his specifications in such a way that he will eliminate any one of them or give one material the advantage over the other. The fact that the natural asphalts are separated from the oil asphalts, for purposes of description, in some of the specifications is no indication that separate bids are received on pavements constructed with the two types of materials. In case this kind of a specification is used, bids should be received upon an equal basis for, if properly handled, one material is in no way superior to the other.

Variations in Temperature Clauses

Temperatures at Paving Plant—Forty-six per cent of the specifications limited the temperature of the asphalt cement, aggregate and finished mixture; 50 per cent limited the temperature of the aggregate and asphalt cement only; 2 per cent limited the temperature of the aggregate only; and 2 per cent limited the temperature of the asphalt cement and mixture only. The temperature range of the aggregate in 30 per cent of the specifications was from 225 to 325 deg. F.; for the asphalt cement 35 per cent called for a limit of from 275 to 350 deg. F.; and for the finished mixture 26 per cent called for the limiting temperatures of from 225 to 325 deg. F.

The temperature limits for the aggregate and asphalt cement should be sufficiently high to allow the two to mix thoroughly and at the same time must be low enough so as not to injure the asphalt cement. The temperature limits for the aggregate should be high enough to compensate for the fact that the cold filler is added to the aggregate before the asphalt cement, but it must be remembered that the larger particles of aggregate will remain at practically the same temperature after the addition of the filler, as they do not readily drop in temperature because of their greater volume.

Reasonable temperatures for the mineral aggregate for this type of construction would be from 250 to 375 deg. F.; for the asphalt cement, from 250 to 350 deg. F.; and if the temperature of the finished mixture is to be specified it should be from 250 to 350 deg. F. It must be remembered that the various asphalt cements are not affected to the same extent by high temperatures and the proper working temperatures are therefore different.

Time of Mixing—In the specifications examined 96 per cent contained a clause that the material should be mixed "until uniform in color and appearance" or a similar clause; 11 per cent required a mixing of at least 1 min.; 4 per cent for at least 1½ min.; 4 per cent for at least 45 sec.; while 2 per cent did not mention how long the mixing should be continued.

The time of mixing is important, as it is essential that the mixture be made uniform and that every batch be the same, otherwise the pavement is certain to "bunch up" under traffic. This is a matter that must be handled by the inspector at the paving plant but it is well to specify a minimum limit on the mixing time. This time limit should be made as short as possible, consistent with good work, and it should be remembered that mixtures containing a high percentage of the larger particles mix much more readily than those made up entirely of the finer material. For modified Topeka mixtures containing a high percentage of material retained on the 10-mesh sieve the minimum time should be 45 sec. The mixing can be more thoroughly and completely done if the man placing the asphalt cement in the mixer is very careful to have it evenly distributed along its entire length, or at least to be sure that it is not placed near one end.

Composition of Mixture

Type of Mixture—Seventeen per cent of the specifications called for the Topeka mixture just as it is described in the decree; 74 per cent were of the modified Topeka type; and 9 per cent did not call for any particular formula.

It has been pointed out many times that it is impossible to expect good results from a pavement mixture which follows the Topeka decree formula without modifications. For this reason that form of specification should be discontinued. If the Topeka decree is to be modified simply by making the sand grading more satisfactory and not by increasing the amount of aggregate retained on the 10-mesh sieve it would be well to make use of the formula which was used by 28 per cent of the cities and states whose specifications were examined. This formula follows:

	Per Cent
Bitumen	7 to 11
Aggregate:	
Passing 200-mesh sieve	5 to 11
Passing 80-mesh and on 200-mesh sieve	10 to 25
Passing 40-mesh and on 80-mesh sieve	11 to 36
Passing 10-mesh and on 40-mesh sieve	7 to 25
Passing ¼-in. screen and on 10-mesh sieve	11 to 25
Passing ½-in. and on ¼-in. screen	5 to 10

If it is desirable to obtain some stability of the pavement mixture through the interlocking effect of the aggregate retained on the 10-mesh sieve it is necessary to increase the amount of material of that size to much more than that allowable under the foregoing formula. Such a mixture has practically never been specified in the past because of the Bitulithic patents even though a great many pavements of this type have been laid under other specifications. Since the basic Bitulithic patent has now expired, it is possible to specify such a

mixture as the following, which is much more desirable than the foregoing under most traffic conditions:

	Per Cent
Bitumen	7 to 10
Aggregate:	
Passing 200-mesh sieve	5 to 10
Passing 80-mesh and on 200-mesh sieve	10 to 20
Passing 40-mesh and on 80-mesh sieve	10 to 30
Passing 10-mesh and on 40-mesh sieve	5 to 20
Passing ¼-in. screen and on 10-mesh sieve	10 to 30
Passing ½-in. and on ¼-in. screen	10 to 40

The finished mixture shall have not less than 40 per cent of aggregate retained on the 10-mesh sieve.

Such mixtures must be controlled within the limits given in the specifications if satisfactory results are to be obtained. A clause stating that the engineer shall have the right to vary the proportions within the limits given should also be included.

Temperature of Mixture on Street—Thirty-three per cent of the specifications called for a temperature higher than 200 deg. F. for the mixture just before it is spread; 15 per cent required a temperature higher than 250 deg. F.; and 17 per cent did not mention any temperature.

The temperature at which the material shall arrive at the street should be placed high enough so that it will insure proper spreading and rolling. A temperature of 250 deg. F. is reasonable for the lower limit. No upper limit need be specified, because the matter of excessively high temperatures is taken care of at the plant.

Roller Should Weigh 7 Tons

Rolling—As in all other types of bituminous pavements the wearing surface must be thoroughly compacted. Such compaction is always obtained by rolling. Eighty-nine per cent of the specifications required that the surface "shall be rolled until no further compression is obtained" or "until all roller marks disappear"; 44 per cent required that two rollers be used; 24 per cent required that the roller or rollers shall weigh from 7 to 8 tons; 20 per cent did not specify any particular roller weight; 28 per cent required that the weight be from 200 to 300 lb. per inch width of tread of the roller; 28 per cent did not specify any particular unit weight per inch width of tread; and 20 per cent limited the area to be rolled to 2,000 sq.yd. per 10-hr. day.

For this type of construction it is not desirable to use a roller weighing less than 7 tons, nor to roll the surface first with a light roller before using the heavy one. A light roller used in advance of the heavy one chills the top surface without forcing the larger pieces of aggregate down into the mortar mixture. After becoming chilled it is then impossible for the heavy roller to compress the surface enough to allow these particles to become properly surrounded with the bituminous mortar. The weight of the roller should also be defined in weight per inch width of tread and the limits should be between 200 and 300 lb. per inch width.

It is always convenient to have two rollers on the job, but if the roller is good, the operator an experienced man, and the output of the plant not more than 200 sq.yd. per hour, one roller will suffice, unless the surface finish is to be put on by the flush coat method. It is well to specify two rollers but that, with the permission of the engineer, one may be used.

Surface Finish—Of the specifications examined 37 per cent required the use of the portland cement or stone dust finish for the surface; 24 per cent called for the flush coat method of sealing; 33 per cent did not require any finishing other than the final rolling; and 4 per cent called for the mixed method bituminous seal coat.

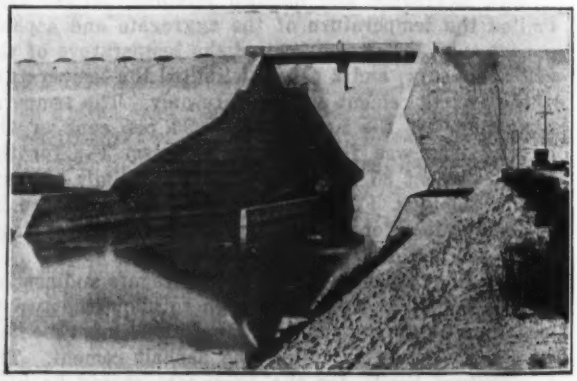
The stone dust or portland cement finish is satisfactory for the finer mixtures, where the amount of material retained on the 10-mesh sieve does not exceed that given in the Topeka decree. For mixtures containing much higher proportions of the larger size the flush coat method of sealing should be used.

Weather Limitations—Forty per cent of the specifications did not place any weather or seasonal limitations upon the work of laying the wearing surface; 22 per cent allowed no work between Dec. 1 and April 1, or when the temperature is below 50 deg. F. unless special permission is obtained from the engineer; and 13 per cent required that the work be discontinued when the weather conditions are not satisfactory "in the opinion of the engineer."

The seasonal limitations given above—work to be discontinued from Dec. 1 to April 1—is entirely too strict in most localities in the United States. Good work can be done when the temperature is below 50 deg. F. if other weather conditions are satisfactory. The temperatures at which work can be properly performed depend upon humidity and wind. For these reasons it is difficult to fix a minimum temperature at which work should be discontinued. It is better to leave this matter to the judgment of the engineer, even though it is always undesirable to have such points so indefinitely stated in the specifications.

Lockington Dam Completed

WITH the completion of the Lockington dam of the Miami Conservancy District, just announced, two of the five detention dams for flood protection of the Miami Valley, in southwestern Ohio, are in service in their final condition. The view herewith shows the main portion of this structure, which in its entirety is 6,500 ft. long and at its maximum 78 ft. high from river bed to crest. It is the longest of the five dams.

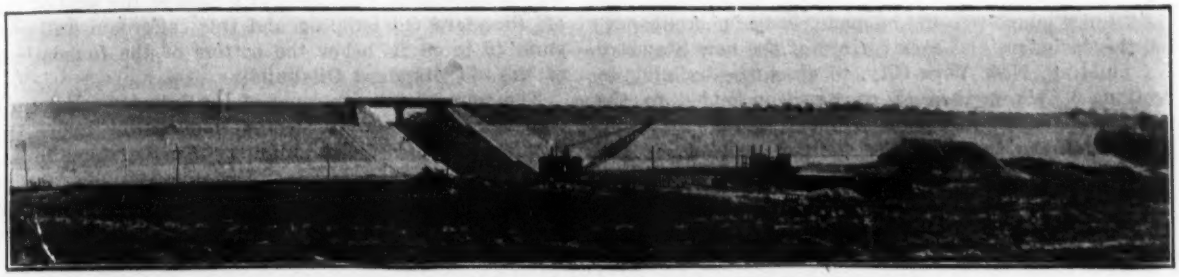


LOWER END OF DISCHARGE CONDUITS AT LOCKINGTON

The Lockington dam controls the flood waters of Loramie Creek, a stream which enters the Miami River just north of Piqua. The two outlet conduits of the dam, each about 8 ft. wide by 10 ft. high, which pass through the base of the concrete spillway weir seen in the view, would discharge about 10,000 second feet under maximum conditions. In a flood like that of 1913,

when the dam would impound water to 60-ft. depth and the basin storage would total 63,000 acre-feet, the conduits would discharge 8,600 sec.-ft. The 72-ft. spillway, 16 ft. below the top of the dam, constitutes a safety provision under maximum flood conditions. The bridge seen crossing the spillway opening carries a 25-ft. roadway across the valley.

About 1,100,000 cu.yd. of material were required to make the dam. Most of this was handled and deposited by the hydraulic method. Enough rock was found in the material to provide for paving the dam slopes below the upper berm with cobble-stones, which provided a very cheap surface protection for the dam slopes. Construction of the dam was in charge of B. M. Jones, Division Engineer; C. H. Shea, Assistant Division Engineer, and G. E. Warburton, Superintendent.



UPSTREAM SIDE OF LOCKINGTON DAM, WITH COMBINATION OUTLET-CONDUIT AND SPILLWAY STRUCTURE

Fire Protection for Railway Timbered Tunnels

OF 151 tunnels aggregating 28.6 miles on the Pacific system of the Southern Pacific Ry., all but 1.6 miles in solid rock were built with timber lining, according to a paper read at the recent annual meeting of the Railway Fire Protection Association, at Chicago, by Harry Pollard, general fire inspector of the Southern Pacific Ry. In the past few years the timbering has been reduced to 20.6 miles by the construction of concrete lining at different places. The following is an abstract of the paper:

Numerous fires have occurred and the difficulties of fighting them are increased by the limited space, the necessity of attack from one or both ends, the lack of light and ventilation, the mass of timber packing in cavities outside of the lining, and the air drafts which come from the portals and through seams in the rock. Three examples of tunnel fires may be noted.

1. A brush fire sweeping over a mountainous district was drawn into a tunnel by the draft. In a few hours the workmen succeeded in closing the ends and steam was turned in from locomotives. After about 48 hours one end was opened, but fire was discovered and when the tunnel was again closed carbon dioxide was forced in for about 36 hours. It was then decided to open both ends and if the fire was still alive to let it burn itself out. In a short time the tunnel was again burning furiously.

2. A torch was left in a tunnel by a repair gang when going out to let a train pass. The lining was burned and the tunnel caved in, a temporary track being laid around it until the tunnel could be restored.

3. A fire from an outside wreck spread to the tunnel lining and into the timber packing. In a few hours the ground caved in and it was hoped the fire would be smothered. Expert firemen from San Francisco were employed to explore the tunnel, using gas and smoke masks, but though they reported the fire was out it soon developed again. A pump and water plug proved of little use, as the fire behind the lining could not be reached. It was then decided to wreck the tunnel and four sets of timbers were blasted out so that the ground caved. In this way the fire was blocked off and sealed on all sides, but the enclosed timber burned as in a kiln, due to the air admitted through cracks in the rock. The water pipe was used repeatedly to cool the rock and to put out fires discovered during excavation of the debris. Only the checking of the fire by the early caving made it possible to get into the tunnel from the opposite end and keep the fire in check.

Sprinkler systems and perforated pipes are of little value in tunnels, owing to the conditions of steam and heat from the engines, damp, corrosion and the possibilities of destructive effect by wrecks. Such protecton is out of the question in view of its cost, the difficulty of maintenance and the lack of reliability in time of need. It is doubtful if expensive fire protection in tunnels is worth its cost. Fireproof paint on the timbers is not satisfactory, as it will not adhere to green timber, it is liable to scale off and no such paint will resist the heat developed in a tunnel fire.

Strangely enough there is no record of fire being started by a locomotive, even in the coal burning days, and the oil burning engines now used are less hazardous. The causes to be guarded against are outside sources, train wrecks and human carelessness. For the first, it is well to clear the ground of brush, trees, grass and weeds for 100 ft. beyond the entrance, and to whitewash the timbering annually for 50 ft. from the portal.

Fire protection equipment needs to be something that is simple and can be used not only by employees but by others, as such outside help has sometimes saved property. Two water barrels and buckets may be placed near each end, or a 5-gal. extinguisher of the type that will not freeze and does not have to be recharged except after being used. At 500-ft. intervals there should be a fire extinguisher and a water barrel with bucket. Where water is available it should be stored in a reservoir or tank with as much head as possible and piped into the tunnel, where hose would be stored. Valves should be about 250 ft. apart, to reduce length of hose, and should be protected by underground boxes.

Electric light should be provided where possible. Open lights, whether oil or carbide, should not be left unattended and should be extinguished while trains are passing. Inflammable material not required for maintenance should be kept outside, and such waste as shavings, small wood blocks and chips from adzing ties and timber should be taken out daily.

Fire prevention can be secured only by fireproof construction, which means solid rock or a lining of brick or reinforced concrete. Brick is not favored, owing to the possibility of knocking out a section and wrecking the tunnel. Concrete will stand more punishment. In the past few years the Southern Pacific Ry. has placed concrete lining in about 6.3 miles of tunnel, leaving 20.6 miles yet to be lined. This work was begun by selecting the most hazardous tunnels and placing concrete for 50 ft. at each end. In bad ground a section of concrete lining was put in, which acts as a fire break.

Foundation Problems in Erecting Standard Oil Building

Adjoining Heavy Buildings Underpinned Down Through Quicksand—Novel Method of Cofferdam Construction

By Ralph H. Chambers
Jarrett-Chambers Co., Inc., Consulting and Constructing Engineers, New York City

THE necessity to maintain existing usable space, until new quarters could be made ready for occupancy, led the designers and constructors of the new Standard Oil building, New York City, to erect the building in sections. This method of construction added to the usual problems of shoring and underpinning the buildings adjoining the site, the further problem of the maintenance of the heavy buildings which still occupied the remainder of the site.

The new Standard Oil building will be thirty stories high and will occupy the site bounded by Broadway, Beaver and New Streets, adjoining the present Standard Oil building. The soil underlying this site is water-bearing clay and quicksand to a depth of 27 to 30 ft. below curb level. Below the quicksand is a stratum of hardpan 13 to 28 ft. thick, lying upon the rock and as the upper layer of the rock was found to be decomposed to a depth of several feet, the sound rock lies at a depth of 41 to 73 ft. below curb level.

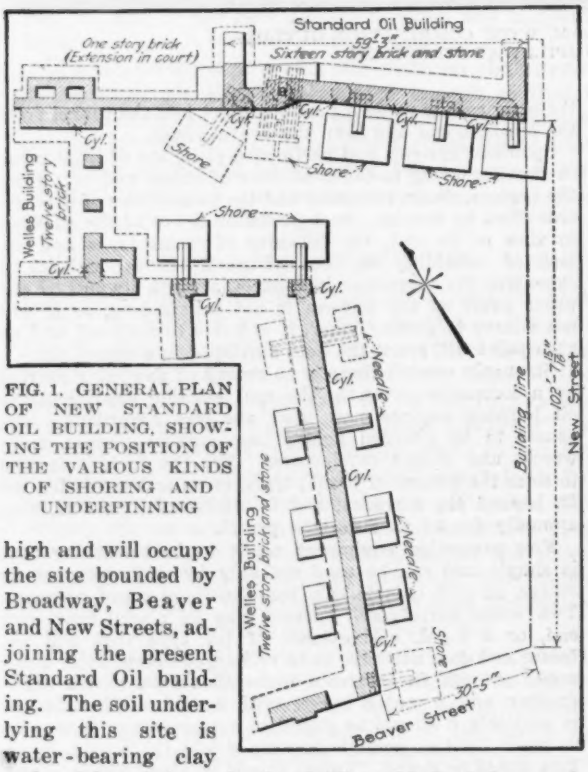


FIG. 1. GENERAL PLAN OF NEW STANDARD OIL BUILDING, SHOWING THE POSITION OF THE VARIOUS KINDS OF SHORING AND UNDERPINNING

The first section of the building will occupy the portion of the site adjoining the Welles building on the west, and the present Standard Oil building on the north, and fronting on New and Beaver Streets. The second section will extend the first section to the west and will occupy the site of the Beaver Street wing of the Welles building.

The plans for the building provide for a deep subbasement under sections one and two, the floor of which will be 37 ft. below the curb level. This requires a cofferdam wall, sunk to rock and entirely surrounding sections one and two. The north side of the cofferdam wall is coincident with the south face of the wall of the old Standard Oil building and this cofferdam wall was sunk 40 to 48 ft. below the bottom of the foundations of the old Standard Oil building.

The foundations for some of the interior columns of the new building were located immediately under the east wall of the Welles building. Furthermore, to advance the date of completion of the new building it was determined to sink foundations for the new building, under the Beaver St. wing of the Welles building, without disturbing the tenants of this building.

Shoring and Underpinning

Confronted with these conditions, it was evident that the south wall of the old Standard Oil building and the east wall of the Welles building would have to be underpinned, and the underpinning would have to be carried down to rock, before the caisson foundations for the new building could be sunk. The theory set up as governing the work to be done to safeguard and maintain the old building was as follows:

First, the foundations of the old buildings being very heavily loaded, would not allow any underpinning work which might disturb them to be begun until adequate shoring had been installed; second, the type of underpinning to be adopted and the method of installation used should disturb to the least possible extent existing foundations; and third, the underpinning installed should sustain the old buildings without dependence upon portions of the old foundation left in place when the work was completed.

Two forms of shoring were used and installed. Needles were placed under the greater part of the east wall of the Welles building and spur shores were used to support the balance of the Welles building wall and the old Standard Oil building. The needle form of shoring was not feasible under the wall of the Standard Oil building without seriously interfering with the operation of the mechanical equipment in the basement. Each set of needles had a capacity of about 300 tons. Each shore under the Welles building had a capacity about equal to that of the needle shores, although the mat was of smaller area. The shores used on the Standard Oil building were of about 500 tons capacity each. By actual test of the screw jacks, the lifting capacity of the shores was determined and the shoring was maintained at its full capacity until the adjacent underpinning was completed. The two types of shoring are illustrated in accompanying photographs.

The needle shores, used in this work, were made up of two sets of steel beams, each set consisting of three 24-in. beams, the upper set supported by the lower. The jack blocks and mats were timber in the usual form and adjustment of the shoring was provided by eight steel screw jacks each 3½ in. in diameter.

The spur shoring consisted of heavy timber mats each carrying as many as twelve steel screw jacks, which controlled the 24-in. square spur shores engaging with the wall to be sustained. It is believed that this

is the first instance of the use of screw jacks with spur shores of this capacity. Experience in this work with this form of shoring, as compared with needle shoring, was very favorable to the spur shores.

It was found that the cost of the spur shoring as compared with the needle shore was somewhat less for equal capacity. Furthermore, the spur shores had the decided advantage in that they could be used without having to gain access to the interior of the building to be shored.

When the underpinning work under the east wall of the Beaver Street wing of the Welles building had been completed, 64 per cent of the foundation of this wall had actually been removed and the portion of the foundation left in place had been subjected to the disturbance caused by the sinking of the foundation caissons under this wall, as well as the underpinning cylinders. Also, 50 per cent of the foundations of the wall of the Standard Oil building had been removed. This work was, however, accomplished successfully and without any settlement or cracking of the walls being noted.

One of the interesting phenomena observed in the action of the shores, was the slow yielding of the soil under the pressure of the shores. When the shores were first installed, after the lapse of some hours the jacks were found to be comparatively loose. The jacks were then tightened and again the yielding of the soil was observed. This action continued for a week or more, depending upon the character of the soil, before the jacks remained tight during a considerable period of time. It would appear from this, that the element of time must be taken into account in foundation work and the determination of the bearing capacity of a pile or footing cannot be made by a single test, but that it must be obtained by a series of tests extending over a considerable period of time.

To conform to the second and third conditions of the theory adopted, it was determined to construct concrete underpinning piers under the walls of the old buildings and to sink these piers by the compressed air method to the rock. In doing this the following method was employed.

The piers were installed by sinking cylindrical steel shells down to a level 2 ft. below the surface of the hard pan and continuing the excavation in the hard pan, without a shell, to the rock. Each steel shell was in three or four lengths and was fitted with air-tight heads and doors so that there was an air lock chamber in the second length of each shell. The excavation to rock completed, concrete was filled in up to the level of the bottom of the wall footing. Air pressure was maintained during the whole operation until the concrete had reached a level above the bottom of the steel shell and had set for 24 hours. After the concrete in the cylinder was set the notch cut in the wall footing was filled with concrete except that a space about 4 in. high was left at the top. This space was finally filled with dry concrete rammed into place. Each of the underpinning piers has a capacity of approximately 700 tons

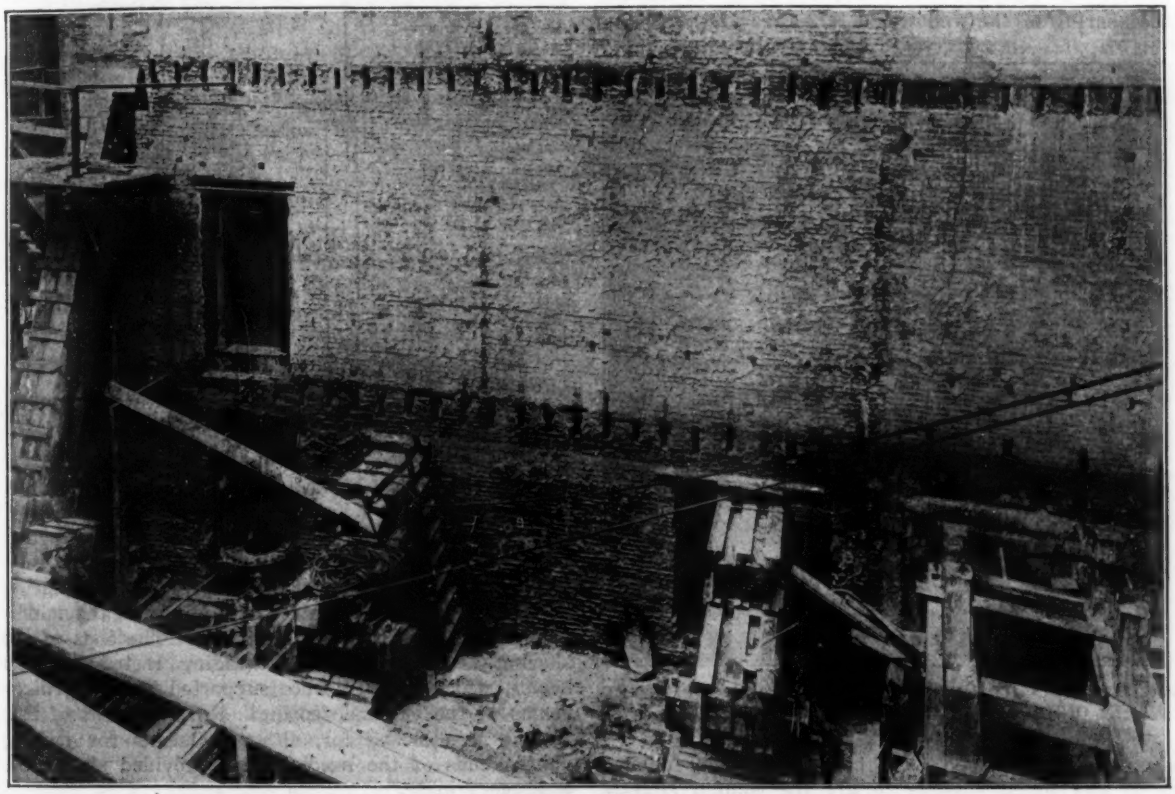


FIG. 2. SYSTEM OF UNDERPINNING BY NEEDLES AND SHORES

Another underpinning difficulty was met in underpinning a steel column which supports a large portion of the weight of the upper six stories of the old Standard Oil building and runs down from the ninth

floor to the foundations of this building. Originally, the present Standard Oil building was ten stories high and later six additional stories were added. These additional stories are supported by a system of distributing and cantilever trusses, resting, in general, on the walls at the ninth floor level. Owing to an offset in the south wall of the building, one of the main cantilever trusses overhangs the wall and the load on this truss is supported by a single steel column which was inserted into the wall and which carries the load from the ninth floor to the foundation at the basement floor. The loading on this column was about 400 tons and the column was apparently well bricked into the original wall, but some doubt was felt as to whether the shoring of the wall would take care of the column

FIG. 3. LONG COLUMN INSIDE BUILDING WAS SUPPORTED ON GRILLAGE SHOWN IN FOREGROUND

also. It later developed that this doubt was well founded as it was found possible to lift the column slightly without lifting the wall.

The shoring of this column was planned upon the assumption that no appreciable settlement of the column could be allowed. Any settlement would redistribute the stresses and reactions in the cantilever girder above. Also it was decided that the footing originally provided for the column would be entirely adequate, even if slightly disturbed by the underpinning operation, if the load were properly distributed on the footing.

Support of the column was therefore provided by a short steel girders connected with each of the two sides of the column by cutting out the rivets near the bottom of the column, reaming out the holes and riveting the girder to the column. To avoid cutting out too many rivets at a time, the girders, placed on each side of the column, were each made up of two similar girders, one above the other, only one of these girders being connected at a time. Between the girders four diaphragms on each side of the column were riveted. These diaphragms were intended to carry the column load to the shoring needles below and in order to distribute

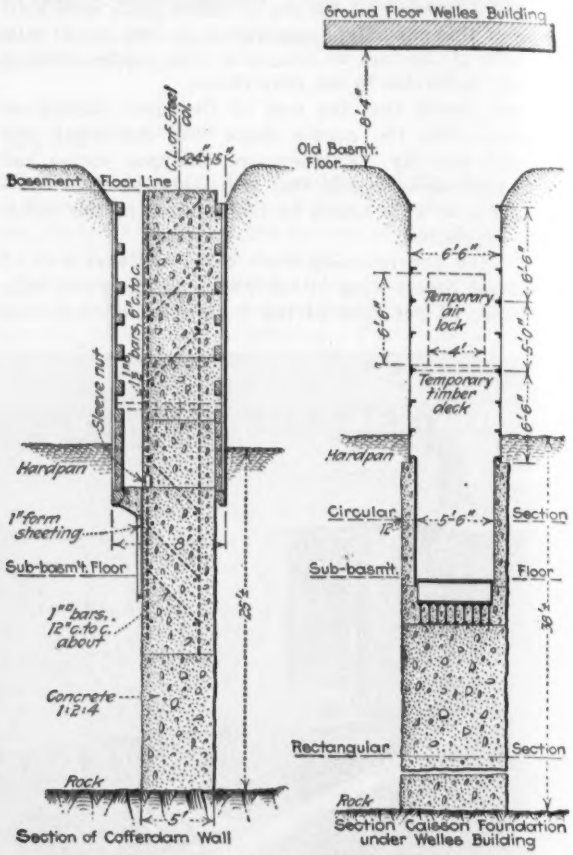


FIG. 4. SECTION OF COFFERDAM WALL AND FOUNDATION CAISSON

the reaction equally to the two girders, the bearing surface of the diaphragms was confined to the middle part of the ends of the diaphragms. The ends of the shoring needles inside the building rested on steel beams, which in turn were supported by the grillage beams of the original footing. No settlement of this footing was looked for, although means for jacking up the ends of the needles were provided should the emergency arise.

The outer ends of the needles were riveted to a distributing beam which was supported only at one point in the middle of this beam. The support under the distributing beam rested upon four screw jacks which in turn rested upon a timber mat on the soil. Thus the column which sustained the floors of the six upper stories of the building transmitted its load to the girders riveted to it and through the diaphragms between the girders the load was carried to the shoring needles and then to the mat on the soil outside the building, and to the footing originally provided for this column inside the building. Thus the column was supported, at its base, by three points of support.

This balanced system of support was deemed necessary as a precaution against unequal loading of the ends of the girders riveted to the column, as any but a uniform loading of these girders would have produced a torsion and would have increased the shearing stresses in the rivets connecting the girders to the column, as well as a bending of the column itself.

After the shoring was completely installed, the jacks were screwed up and it was found that the column

could actually be lifted. This shoring accomplished, the masonry under the column was cut away and an underpinning pier was sunk under the column. The shoring was then removed. The work was accomplished without any settlement of the column.

An unusual condition was met in installing the foundation for the first section and in putting in the sub-basement walls. Only two sides of the cofferdam to include the sub-basement could be constructed until after the building, which occupied the site of the second section, had been demolished and the foundations for the columns of the first section of the building which were within the area enclosed by the cofferdam had to be sunk from the surface.

In the construction of the cofferdam wall, to take advantage of the comparative shallow depth of quicksand and to limit the thickness of the wall to a minimum, timber caissons were sunk but these were carried only a short distance into the hardpan. From the bottom of the timber caissons the excavation through the hardpan down to the rock was limited in width to the required thickness of the finished wall. When the excavation had been completed the concrete was carried up to a level just above the bottom of the timber caisson and having been allowed to set, the air pressure was taken off, the deck of the caisson removed and the wall was finished in the open cofferdam. The timber bracing was removed as the wall was carried up.

It will be evident that the method adopted makes it possible to limit the thickness of the wall to any desired minimum. This cannot be accomplished in the ordinary method because the thickness of the working chamber walls govern the minimum width of the cofferdam wall. Also the method used in this work makes it possible to build a cofferdam wall which is continuous from the rock to the top without any cause for apprehension as to possible voids left unfilled under the roof of the working chamber.

In putting the caissons under the Welles building a cylindrical steel shaft was sunk under air pressure, into the surface of the hardpan. A temporary wooden deck was used to form a working chamber in the shaft and a small lock was bolted to this deck. The excavation was carried down through the hardpan below the bottom of the steel shaft to the rock and was extended laterally to a rectangular section of the dimensions desired for the column footing. The concrete was then carried up to the bottom of the steel grillage and the grillage was set under air pressure.

This work was done under the direction of Theodore Pratt, of the Standard Oil Company. The architects are Carrere & Hastings, Shreve, Lamb & Blake Associated. Charles T. Wills, Inc., is the builder. The plans for the foundation work were made by the Jarrett-Chambers Co. and the work was done by that firm.

Refuse Pulverization in English Towns

The Borough of Oswestry, England, has adopted a system by which its refuse will be pulverized for utilization on land. We are informed by G. William Lacey, borough surveyor and water engineer of Oswestry that, before pulverization of the mixed refuse, tins, metal, rags, and bottles will be sorted out for sale. Mr. Lacey also states that the same general system is now in operation at the Borough of Southwark, London, and at Bury, Durham, Gateshead, and elsewhere.

St. Paul City Planning Projects Form Broad Scheme

Arcade Sidewalks—Improved Street System—Bridges and Viaducts—Civic Center—Use of Vacant Land—Railroad Work

A COMPREHENSIVE scheme of municipal improvements proposed by the City Planning Board of St. Paul, Minn., in order to give better routing of traffic around and across the city and to relieve the serious congestion of traffic in business districts, includes sidewalk arcades, street widenings, linking up streets into continuous main thoroughfares, a civic center, railway grade crossing elimination, and bridges at some street intersections to provide for grade reduction of streets. Parks and parkways and some work to improve the appearance of the city are auxiliaries of the main scheme. Some of the projects have been adopted already by the municipal authorities. The following review of the situation is prepared from information furnished by George H. Herrold, city planning engineer for St. Paul, and from a report to the City Planning Board by Edward H. Bennett and William E. Parsons, consultant city planners, Chicago. A general plan of the improvement scheme is given in Fig. 1 and a more detailed plan of the difficult and costly works in the central portion of the city is given in Fig. 2.

Improvements in Street Layout

A rectilinear street system applied to a site of irregular topography has led to unfavorable traffic conditions in St. Paul by lack of continuity of several major streets. There is still opportunity to correct this defect, however, by opening new connections and by connecting dead ends of streets at topographic breaks by viaducts in order to establish major arteries both through and around the business district and afford direct communication with the east, west and southwest districts. The heavier grades on existing streets range from 4½ to 11 per cent, but the improvements provide for a maximum of 3 per cent on all main traffic routes. Incidentally, it is stated that the rectilinear street system has cost the city more than $6,000,000 for grading.

A conspicuous example of the inadequacy of the present street layout is that between 7th and Maryland Sts., a distance of nearly two miles, there is no other east and west street to serve as a crosstown line. This defect will be remedied by the proposed plan. Districts north and northeast of the business district are reached now by zigzags only causing inconvenience, increased costs of transportation and hindering the development of the districts in which they occur. Diagonal cut-offs are proposed to remedy this condition.

Where major streets having street car lines are paralleled closely by other streets suitable for light vehicles, it is planned to develop traffic on the dual arteries rather than to incur the expense of widening the major street. In most cases, however, the only way of increasing the traffic capacity is to widen the street. Much of the heavy traffic to and from the freight terminals, local yards, warehouses and wholesale houses now passes through the central business district. To widen many of these streets would involve prohibitive expense, but by providing a circuit of wide streets around this district the through traffic may be diverted with advantage to both through and local traffic. This circuit includes 3rd, Wacoutah, 12th and Main Sts.

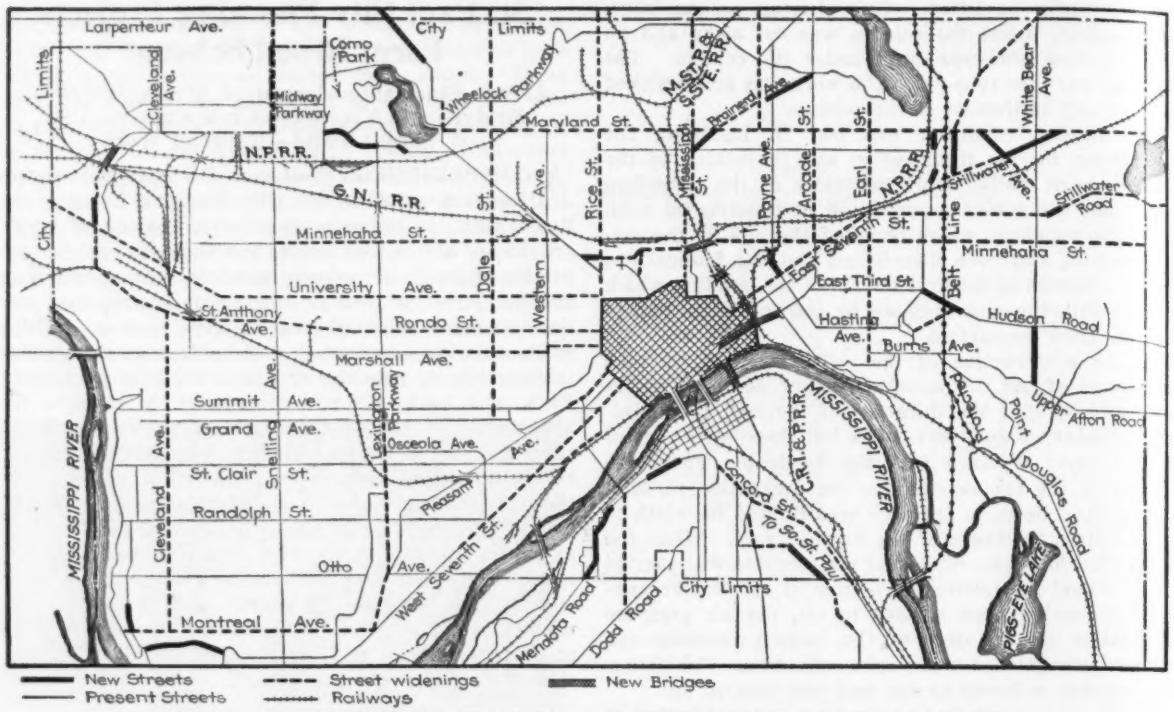


FIG. 1. STREET IMPROVEMENTS FOR THROUGH ROUTES AT ST. PAUL, MINN.

The value of special thoroughfares for the use of motor trucks has become apparent with the rapid increase in this form of traffic. Unless such thoroughfares are provided, giving direct routes and easy grades, the trucks will continue to mingle and interfere with the traffic of business and residential streets. Several truck routes are proposed.

Arcades in Business District

In the central business district the street area is only 29 per cent of the total, as compared with 35 per cent in Chicago and 37 per cent of Minneapolis. In addition to this defect, St. Paul has sacrificed sidewalk space to provide greater freedom of movement for vehicles, the streets in the business district having 40-ft. roadways and 10-ft. sidewalks, except that in Robert St. (widened) the respective widths are 49 and 13 ft. In all these streets the sidewalks are inconveniently congested and this congestion will increase with the construction of higher buildings. For proper capacity on 7th St., for example, a sidewalk width of 22 ft. would be required. But as the roadway widths are barely adequate, and in some cases are inadequate, for vehicle traffic, there is no opportunity for widening the sidewalks at the curb.

Arcades through the street fronts of the buildings are the only remedy for such conditions. This remedy was applied a few years ago on 7th St., the first-floor store fronts being set back 24 ft. from the building line and the wall columns of the buildings being concealed within columns of architectural treatment. It is proposed to extend this system to St. Peter St., by acquiring an easement of 20 or 25 ft. within the building line. A further advantage of this plan is that it will permit widening the roadway 14 ft., the curbs on each side being set back 7 ft., thus leaving a 3-ft. open sidewalk outside of the arcade.

A novel extension of this plan is to carry arcades through the middle of certain blocks, as shown by the plan. It is expected that these arcades will provide ample circulation for pedestrian traffic in the center of the retail district for several years. It is proposed in some instances that vehicles be allowed to use them during the night to serve stores, restaurants and offices.

Apart from this special sidewalk problem the improvements within the business district include the following: Wabasha St. widened to 86 ft. by a 26-ft. strip on the west side; 8th St. widened 25 ft.; 12th St. widened 50 ft. and extended, as shown, to form an east-and-west artery; Wacoutah St., widened to 84 ft. and extended; Broadway widened 40 ft. on the east side, as it receives all the heavy trucking of the freight terminals. In addition to arcading 7th St. and widening its roadway from 40 to 56 ft., it is proposed to widen it to 106 ft. beyond the business district and eventually to build a subway for the car line.

At the new Union Station it is planned to improve appearances and traffic accommodations by cutting a 100-ft. plaza from 4th to 5th Sts., widening 4th St. by 36 ft. (to 96 ft.) and widening Wacoutah and Sibley Sts. by 24 ft. (to 84 ft.) between 4th and 6th streets.

Auxiliary Improvements

Although the improvement of the street system is the main feature of the present plan there are a number of important developments more or less closely related to the general scheme.

Bridges—It is planned to widen the bridge over the Mississippi River on Wabasha St. and to rebuild the Robert St. bridge. The latter is of particular importance as the street was widened a few years ago and will be the main traffic street for many years. Pending entire reconstruction it is suggested that the piers can be extended and a third line of trusses placed for the deck span, a new truss channel span being required. Both of these structures are high-level bridges without

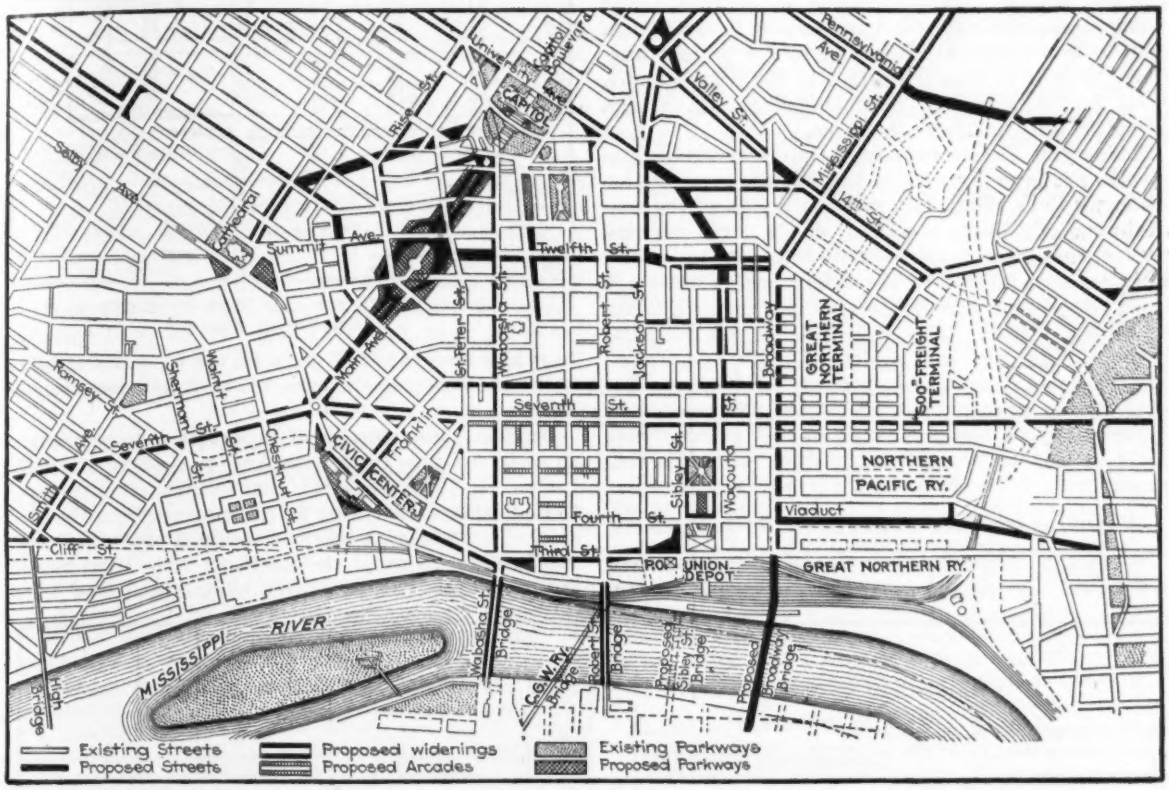


FIG. 2. PROPOSED "CITY PLAN" DEVELOPMENTS IN CENTRAL SECTION OF ST. PAUL, MINN.

drawspans. They are level with the streets on the north side of the river and have 3½ per cent grades in the south approaches from the district known as Riverview.

For an additional bridge to serve the business district there are two rival plans for Sibley St. and Broadway respectively, as shown in Fig. 2. The former would be a low-level bridge with draw and has been authorized by Congress, but there is considerable opposition to it on the following grounds: (1) That being so near Robert St. it will depreciate property which has paid heavily for street widening; (2) that it will interfere with the car routing scheme and the development of river traffic; (3) that its approaches will interfere with heavy traffic on cross streets and with that of the new U. S. Post Office at Sibley and 3rd streets; (4) that it will increase rather than relieve congestion, as Sibley St. is not a continuous thoroughfare or artery and has recently been narrowed between 3rd St. and the levee to give 30-ft. additional length to the headhouse and stub tracks of the new Union Station; (5) that being a low-level bridge, the opening of its drawspan will back up traffic in the entrance of the C., M. & St. P. Ry. freight station and completely block any movement of traffic here while the span is open.

The Broadway bridge location is strongly recommended by the City Planning Board as an essential element in the growth of the city. The proposed plan provides for widening Broadway, which is not only a main artery but would be connected by the bridge with State St., an arterial thoroughfare in West St. Paul. It is considered that a bridge on this location would relieve the traffic congestion of the business district, and being at a high level it would require no drawspan.

To open additional communication across railway property it is proposed to build a viaduct connecting Minnehaha St. with Pennsylvania Ave., and to replace the old 3rd St. viaduct with one on the line of 4th St., giving a better approach to the Union Station. This latter project has been taken up with the railway companies, which are committed to the rebuilding of the 3rd St. viaduct.

Railways—A thorough investigation of the railway situation in its relation to the city's interests is under way, but it is pointed out already that there is opportunity for improvement in three directions: (1) Separation of grades at street crossings; (2) electrification of certain lines to reduce smoke and noise; (3) detouring through freight to avoid congestion of the city terminals. In this last part of the program would be included the proposed Twin City Belt Line described in *Engineering News-Record*, Oct. 25, 1917, p. 784, the construction of which was stopped by the war.

Capitol Boulevard—A conspicuous feature in the City Plan, Fig. 2, is the proposed boulevard approach from Seven Corners to the State Capitol, which is slightly modified from plans approved by the Capitol Approach Commission. Although this is included as a logical part of the general scheme it will be paid for by the State as part of the capitol developments, but as financial conditions are unfavorable the plans have not yet been presented to the state legislature.

Civic Center—The present city and county building, now 40 years old, is so inadequate that several departments are located in rented offices. It occupies a highly valuable site in the center of the business district. In selecting the new site shown on the plan, the controlling conditions were: (1) It is easily accessible but out-

side the line of future business development; (2) although convenient to street car lines it is far enough away to avoid the excessive noise of the present location; (3) it is in logical relation to the State Capitol, Union Station and other public buildings, all on high ground in full view from the river.

Zoning and Vacant Property—Only a tentative zoning plan has been prepared so far, but the investigation as shown the striking fact that nearly half of the area within the city limits is vacant, due to large outlying areas having been taken into the city during a real estate boom in 1887. In the accompanying table are shown the present uses of the area and the uses under the proposed plan. The area includes the adjacent streets. With the new distribution the population could be doubled without increasing its density. But before such a growth could be reached there would be expansion beyond the city limits, so that major streets should be planned to meet future suburban traffic conditions.

Examples of "City Plan" Projects Adopted

Two specific improvements which have been approved by the City Council and for which condemnation pro-

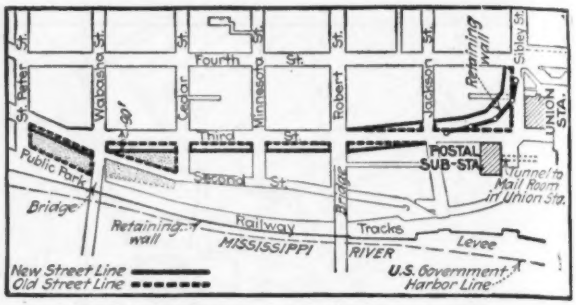


FIG. 4. WIDENING AND NEW CONNECTION ON THIRD ST.

to reduce the grade to 6 per cent, the latter street being carried across the avenue by a handsome concrete bridge.

Further, the alignment of Robert St. is to be changed so as to run into University Ave. on a curve of 192-ft. radius. In 1913, Robert St. was widened from the river to Central Ave. by taking 20 ft. of property on the west side. This widening will be continued to Aurora Ave., but in order to avoid the Mechanic Arts High School, the center line will be shifted slightly and land taken

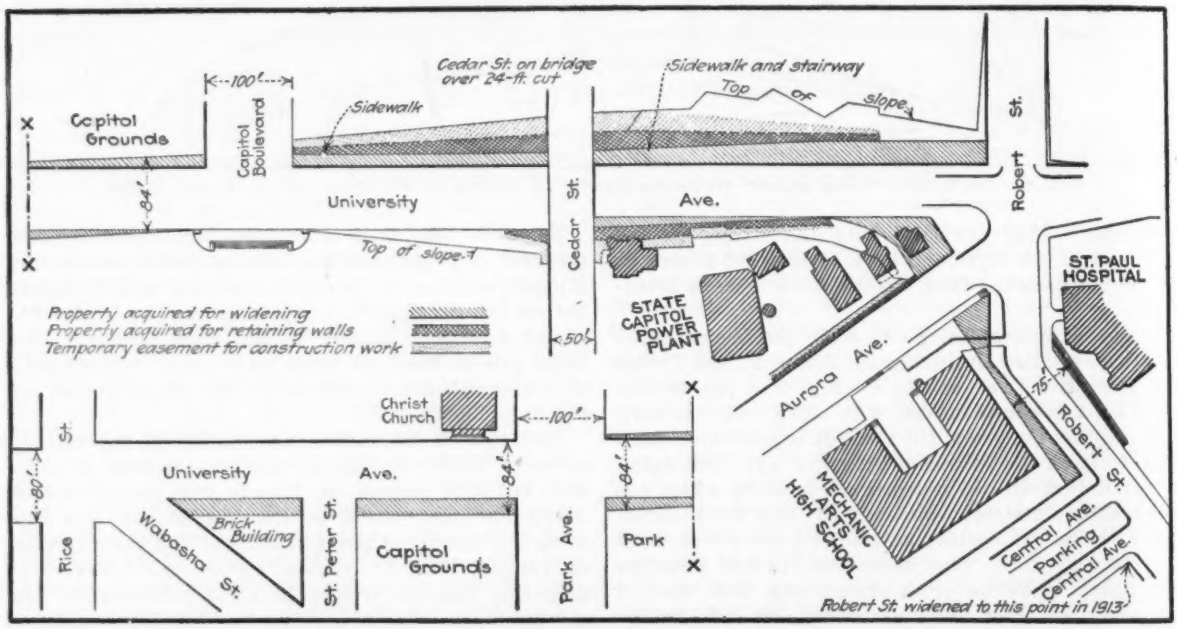


FIG. 3. GRADE REDUCTION AND WIDENING ON UNIVERSITY AVE. AND ROBERT ST.

ceedings have been started are the widening and grade reduction of University Ave. and the widening of Third St. These are described below as being illustrative of the various improvements included in the proposed plans.

University Ave. Improvement—This main artery to the State University and the adjacent city of Minneapolis is 120 ft. wide from the city limits to Dale St., 80 ft. for about a mile to Rice St. and then from 60 to 72 ft. wide as far as Jackson St. It is proposed to make it 120 ft. wide to Rice St. and then 84 ft. to Jackson St., beyond which a new 84-ft. street will extend it to Wacoutah St. (see Fig. 3). There is a descending grade of 10½ per cent from Cedar St. to Robert St. and 6 per cent thence to Jackson St. It is proposed to lower University Ave. about 24 ft. at Cedar St., in order on both sides, as shown, the 75-ft. width increasing on the curve to fit the 84-ft. width of the avenue.

For this new connection, the acquirement of property, change of grade, construction of retaining walls and repaving are estimated to cost $225,000, which will be paid for in assessments against the property along Robert St. In consequence of objections made by property owners who are in the assessment district but not on the street, the Robert St. property owners have agreed to shoulder the entire cost of the improvement if the city will order it carried out. This action affords further evidence of their belief in "city planning" projects as they paid about $1,000,000 for the widening of the street in 1913.

Third St. Improvement—A more expensive project is the widening of 3rd St. in the retail district along

PROPERTY USE OF LAND IN ST. PAUL, MINN.

Use	Present Sq.Mi.	Present per Cent	Proposed Sq.Mi.	Proposed per Cent	Increase per Cent
Residence	17.06	30.75	36.60	66.00	215
Industrial, railway lines and yards	3.77	6.69	8.32	15.05	225
Business	0.90	1.62	2.00	3.61	222
City property and parks	2.98	5.33	5.25	9.44	176
Rivers and lakes	3.27	5.90	3.27	5.90	...
Vacant	27.46	49.71	.....	.....	...
Total within city limits	55.44	100.00	55.44	100.00	...

the river, as shown in Fig. 4, the cost being estimated at $1,400,000, including new fronts for the buildings. The present width of 53 to 57 ft. will be increased to 90 ft. and the city will acquire the property indicated to form a park at the head of the Wabasha St. bridge, this park being on the edge of the bluff, 80 ft. above the railway tracks along the river bank. From this point 3rd St. and 2nd St. have descending grades eastward.

Thirteen Projects Submitted for San Francisco Bay Bridge

AT THE hearing on the proposals to bridge San Francisco Bay before Col. Herbert Deakyne, Corps of Engineers, U. S. A. on Oct. 7 (*Engineering News-Record*, Oct. 13, p. 627) thirteen separate projects were put forward. Their main features are outlined in the accompanying table. Some special features may be emphasized in the following notes:

"Floating Cantilever" Bridge.—The plan of the Union Construction Co. carries the weight of structure and traffic on a floating support of reinforced concrete pontoons, thus eliminating the foundation problem. The lateral stability of the structure is provided for by 4-post towers, 960 ft. apart, held in place by cables to anchorages in the bay bottom. The structure is made up of sections 320 ft. long connected by pin joints, each section being a rigid unit supported on two pontoons. The pontoons are 40 x 90 ft. in plan and 14 ft. deep, placed transverse to the roadway on 160-ft. centers. In each rigid unit steel trusses span the distance between the pair of pontoons and also carry the roadway for the 60-ft. cantilever projections on each end. The design provides for a live-load of 100 lb. per square foot.

The "Suspended Tube."—The plan proposed by Mr. Greene calls for a tube of stream-line cross-section, built in sections of either steel or concrete which would be flanged, gasketed, and bolted together. Messenger cables, used for construction purposes would later be supplemented by cables within the tube. Sections would be made with end faces sloping on a 45-deg. angle. By means of rails along the tops of the sections and down the inclined faces, fitting corresponding parts on the under side and rear face of each section, successive sections would be hauled along on top of the completed portion of the tube and allowed to drop into place. Detachable faces at each end would be removed when the outer shells were secured.

The Fowler Plan.—The plans filed with this proposal were the same as were submitted some seven years ago, (*Engineering Record* Oct. 10, 1914, p. 398) with some additional suggestions regarding terminals. By the use of an elevated loop it is now proposed to handle traffic from the top of Telegraph Hill on grades not exceeding 1½ per cent. The main bridge spans would consist of two 650-ft. cantilever arms and a 700-ft. suspended span. Four supports in the stream would each consist of two piers on 250-ft. centers. The total length of crossing on this route would be 20,500 ft.

Davies and Modjeski Plan.—The route recommended by these engineers is practically the same as the one proposed by John G. Little and C. H. Snyder, described in *Engineering News-Record* July 7, p. 16. The Davies-Modjeski report was reviewed in *Engineering News-Record* Aug. 18, p. 269.

SAN FRANCISCO BAY BRIDGE PLANS FILED WITH WAR DEPARTMENT

Proponents	Engineers	Type of Crossing	Provision for, and Width of Ship Channel	Western Terminus (S. F. Side)	Eastern Terminus	Width of Roadways No. of Tracks	Estimated Cost (Dollars)	Remarks
San Francisco Bay Bridge Committee	Davies and Modjeski	Tunnel and Bridge 300-ft. spans	2,500 ft. unobstructed	Near Fifth and Townsend Sts.	Western end of Alameda	40 ft. vehicular, 2 R.R. tracks	40,000,000	40 ft. of water over tunnel
C. H. Snyder	Little and Snyder	Tunnel and viaduct	2,500 ft. unobstructed	About 1 mile S. of Market St.	Western End of Alameda	28 ft. vehicular, only	15,000,000	50 ft. of water over tunnel
Union Construction Co.	W. P. Roop	Concrete pontoons	440-ft. swing span	Hunter's Point	Point on line with Oakland City Hall	40 ft. vehicular only	8,000,000	.....
E. B. and A. L. Stone	H. F. Droste	Double deck concrete viaduct	250-ft. double-leaf bascule	S. Side of Hunter's Point	Bay Farm Is.	35 ft. vehicular 4 R.R. tracks	13,130,000 to 16,000,000	.....
L. E. Fowler....	Fowler, Wing, Duryea, Haehl	High level cantilever bridge, 2,000-ft. spans	210 ft. clearance under bottom chord	Telegraph Hill	Goat Is.	40 ft. vehicular 4 R.R. tracks	75,000,000 (1916 prices)	R.R. yards on N. Side of Goat Is.
R. S. Chew	R. S. Chew	High level cantilever bridge, 2,000-ft. spans	210 ft. clearance under bottom chord	Telegraph Hill	Goat Is.	70 ft. vehicular 6 R.R. tracks	50,000,000 (exclusive of approaches)	Three trusses, double deck
E. M. Greene	E. M. Greene	Tube suspended on cables	Unobstructed	Market St.	Y to Key Route and S. P. Moles	4 auto roadways 4 R.R. tracks	.....	.....
A. J. Rich & Co.	Gustav Lindenthal	Concrete arches 150-ft. spans	Double leaf bascule, 200-ft. channel	Candlestick Point	S. Side of Alameda	60 ft. vehicular 6 R.R. tracks	25,000,000	Entirely on curve of 4-mi. radius
100% Club	C. A. Pistolesi	Concrete pile viaduct	200-ft. bascule	Little Coyote Knoll, 18. mi. So. of S. Fran.	Near Albarado	21 ft. vehicular R.R. tracks later	2,500,000 (including approaches)	.....
M. C. Couchot	M. C. Couchot	Tunnel 25,000 ft. long	Unobstructed	Harrison St.	Between Moles of S. P. and W. P. R.R.'s	26 ft. vehicular 2 R.R. tracks	30,000,000	100 ft. below water level
H. C. Holmes	H. C. Holmes	Concrete viaduct	140-ft. single leaf bascule	S. Side Hunter's Point	Mulford Landing	40 ft. vehicular only	5,000,000	Construction period of 18 months
San Mateo Co. Board of Supervisors	Geo. A. Kneese	Concrere viaduct	125-ft. drawbridge	Dumbarton Point, 30 mi. S. of S. Fran.	South of S. P. R.R. Bridge	20 ft. vehicular only	1,450,000	.....
O. A. Ellis	O. A. Ellis	Double bore tunnel	Unobstructed	Harrison St.	S. P. Mole	24 ft. vehicular 2 R.R. tracks	12,000,000	200 ft. below water level

What Business Papers Can Do to Speed the Revival of Business

An Address by James H. McGraw, President of the McGraw-Hill Co., Inc., New York, Before the Annual Convention of the Associated Business Papers, Inc., Chicago, Oct. 24, 1921

TO INTERPRET *to American business the bearing of world conditions upon each of our industries and to lead in the advocacy of broad, sound policies in reference to both foreign and domestic economic problems is the duty and the great opportunity of the business press at the present critical moment: such is the view of James H. McGraw, president of the McGraw-Hill Co., Inc., in an address before the convention of the Associated Business Papers at Chicago last week. Mr. McGraw's paper, while not addressed to engineers and contractors, will nevertheless interest them because of his strong grasp of the present situation, his vision and his courage. The opportunity he pictures to the business press lies at the door, though obviously in less degree, of every thinking man.*—EDITOR.

There are two great classes in the world today—those who look on the world in chaos and see no hope for the future and those to whom the world disaster is but an inspiration for greater effort. I am putting the business papers in the latter class.

The leader of today is the man looking straight ahead with new thoughts or with new vision of old thoughts. The business publisher as never before must grapple with the great problems before us, with new thought and new vision and with a full knowledge of world conditions.

Let us picture these world conditions of the moment.

THE EUROPEAN CRISIS

Across the Atlantic the financial systems of Central Europe are going down in a horrible crash. The Austrian crown and the German mark sell at 1/300 and 1/50, respectively, of their gold value, and since there is no such thing as isolation in the economic world, we, innocent of the causes, must share the burden with Europe.

Germany is in the throes of another cabinet crisis, with the danger of losing the gains of some eighteen months of political peace.

Russia daily slips deeper into the slough of economic dissolution—though possibly the deeper she goes, the quicker will come the day when her 180,000,000 people will again buy from the outside world—a buying, by the way, essential to a normal world functioning.

Petty wars still rage in Europe, despite the nominal advent of peace three years ago.

AMERICAN CONDITIONS

Such, in a word, is the situation in Europe. In America conditions are more hopeful.

We have a tremendously improved banking and credit situation and plentiful evidences that we have passed the low point in the curve.

The oncoming disarmament conference has awakened the hopes of the world in the possibility of turning into productive lines millions of treasure that go into armaments, and of settling the terms on which America and all other nations shall do business with China.

But, while there are bright spots in the business firmament, there are also heavy clouds. Right before us looms a nation-wide railroad strike. When that cloud has dissipated, or after it has been weathered, we shall probably find ourselves hard up against a coal strike, for while the operators are ready to agree to arbitration in settling the wage scales which come up for renewal on March 1, the coal miners are unwilling to give up the strike weapon.

Quite disturbing, too, is the fact that 4,000,000 of our people who want to work, who want to make the goods and build the houses necessary to make up for our war depletion and shortage, are unable to work, and between 10 and 20 per cent of them are either in want now or will be with the advent of cold weather. While this in itself is disturbing, far more important is the evidence it affords of our failure to have developed a sound social system, in which the functioning of industry must necessarily prove an integral part.

Business is stagnant, yet a dallying Congress, imitating Nero, plays the fiddle of back-home politics while business goes to pot. The tax bill languishes on Capitol Hill. The tariff measure, universally condemned, has been shelved, casting just so much added doubt upon the business future. The railroad refunding bill makes no progress. All that could stabilize business and restore confidence is neglected, despite the urgings of an administration that displays a gratifying amount of business sense.

INTERPRETING THE SITUATION TO BUSINESS

Such are some of the features of a world situation unprecedented in complexity, in difficulties and in the number of discouraging features.

Each and every one of the situations referred to has a present-day bearing on American business. What is more, some of them will determine how America is to do business for many years in the future. If American business is to function up to the new position that has come to it during the war, and that necessarily flows from the fact that the center of world finance and of world influence has shifted to our shores, these governing conditions must be interpreted in terms of their influence on every industry. We may become, if we have but the knowledge, the foresight, and the energy, what England has long been—the market center of the world. But we can take this position only if we have a race of business men equal to the occasion—a race worthy of a world-wide commercial dynasty.

How shall American business men get this conception, how shall they rise to this opportunity unless the business press carries the message to them in each issue, strong with knowledge of the situation and its bearing on American business, convincing in the wisdom of the remedies it suggests, invincible in the enthusiasm and courage it displays?

It is no job for weaklings, but for the broadest-gaged men that the country commands. It will not be accomplished by editors chained to their desks, nor by mere reporters nor by publishers who are bearish on America's future. It can only be accomplished by men of broad vision, sound judgment and unfliching courage.

As to European and other world factors which bear on American business, there must be a wise policy carried home constantly by the business press. We must help mobilize American opinion on the stabilization of European currencies. When Russia comes back, when the other weakened powers are in a position again to buy in normal quantities the business press must picture the opportunity and be the apostle of whatever credit structure is necessary to bring these nations again into the world economic family.

Likewise, as to every other factor in the European and the world situation, business papers must rise to the occasion and help American business to adopt a wise and courageous policy.

INTERPRETING OUR OWN SITUATION

This task of interpreting world conditions to American business is not an easy one, yet it is only part of the great job which American business paper editors and publishers must do. We must necessarily be concerned with the affairs of the world, but naturally our first responsibility is for our own country, for our own industrial, economic and social conditions. Studying the problems that are closer to home, we find many avenues along which business papers can work in speeding the revival of business.

War breeds extravagance. In spite of the noble ideals which inspired this nation to take up the great conflict across the seas, the inevitable result was the accumulation

of innumerable wastes and habits of extravagance. We became wasteful of our time, our money, materials and even life itself. We could not help it, but we can and we must overcome the habits and tendencies which were developed throughout our entire social and industrial fabric by that terrible conflict.

As a tangible example of what can be done, Herbert Hoover has focused the attention of industry upon the unnecessary wastes which are sapping the vitality and reducing the productivity of our nation.

We are appalled when our attention is called to criminal wastes of life through accidents and negligence, the prodigal waste of our natural resources through under development or political chicanery, the prodigious waste of materials through mismanagement and inefficiency. But of all the wastes which affect our happiness and prosperity, the waste of time and human effort is the greatest and has the most damaging influence.

Along all these lines the business press must constantly be urging and championing broad, sound policies.

Its greatest single task, though, looking to domestic conditions, is to bring home among thinking men that what this country needs more than anything else is to learn anew the gospel of work—intelligent work, untiring work, work in its most homely sense.

We cannot talk ourselves into prosperity. We cannot argue ourselves into stability, but we can work ourselves out of the valley of depression and up to the heights of plenty. We must do these three things:

First, urge everybody to get busy at his present task, and make the most of it.

Second, demand that everybody consider the "winning of the peace" in the same spirit as characterized the winning of the war.

Third, show that selfishness has now no more place than in war time; that interest in the welfare of all men, individually and as society, lies at the basis of prosperity.

In conclusion let me say, we must consecrate ourselves to giving a full measure of the best service we have within us. As a nation, and as publishers, we must quit our petty quarrels and arguments and devote ourselves to the tasks that lay before us. We had to *fight* and *destroy* to win the war. We will have to *work* and *build* to win the peace. The first nation that gets hold of the idea that the only salvation comes from work, will come out on top and really win the peace.

The business papers have an opportunity such as has never come to them before, to direct the thinking of industry into sane channels. Let us demonstrate by our own untiring efforts to serve and by our diligence in meeting the problems of the day that we have accepted the gospel of intelligent work as the big step in speeding the revival of business.

Increased Speed On Tie Perforating Machine

The machine developed for perforating railroad ties preliminary to a preservative treatment and which was described in *Engineering News-Record*, April 28, 1921, p. 730, has been moved to San Diego, Cal., and set up with a somewhat different arrangement that has made possible an increased speed of handling the ties. The greased plank formerly used for conveying ties to the perforating rolls and delivering them to cars after passing through the machine, is now replaced by moving chains. To keep the machine running at capacity, ten men are required—4 unloading, 1 watching the chains, 4 loading the perforated ties upon the cars and 1 mechanic. With this arrangement 3,600 ties can be handled in eight hours. As about an hour per day is lost in switching cars to and from the machine, the actual maximum rate of passing through the machine is about 500 per hour. Several hundred thousand ties were treated by this process in the lumber yard of the Charles R. McCormick Co. at San Diego for the Santa Fe Railroad.

Low Grade Line Saves Pavement From Flood Damage

By C. L. Jenken

Construction Engineer, Maricopa County Highway Commission
Phoenix, Ariz.

UNUSUALLY heavy rainfall, coupled with the failure of a dike 10 miles northeast of Phoenix, Ariz., recently caused a flood that swept across about 30 miles of the road system built by the Maricopa County Highway Commission. The currents were so swift that it was expected at least 5 miles of the concrete pavement, which took the brunt of the flood, would be almost a total loss. However, when the waters had subsided an inspection trip showed that $125 in repairs to dirt shoulders would cover all the damage. The success with which the pavement resisted this flood is ascribed in part to the design of the slab but chiefly to the fact that the danger of flooding by irrigation water had been taken into account in the original plans for the system and had resulted in a decision to keep the grade line low.

An exceptionally large runoff from the Cave Creek water shed had caused flood waters to back up water behind the south bank of an irrigation canal just north of and above this part of the road system. When this embankment was overtopped the impounded water was released onto land which has an average fall to the south of about 10 ft. to the mile and to the west of about 8 ft. to the mile, thus creating very strong currents especially where the water reached a depth of 18 to 24 in., as was the case along several of the roads inundated. The danger of damage to the roads was increased by the high ditch banks built in many places along the edge of the right-of-way on the lower side, thus tending to keep the water current running for considerable distance parallel to the edge of the pavement.

Danger From Irrigation Water

When this road system was being planned, the final location was made so that the grade line was held down to a point where the cuts would equal the fill without utilizing any material borrowed from pits or side ditches. In fact, the drainage ditches already existed in many cases, having been built to care for the waste water from irrigation. In keeping the grade line low the object was not to reduce the danger of floods from the Cave Creek water shed, as this was not anticipated, but was rather to prevent damage from irrigation water that occasionally escaped onto the roads. The latter was a considerable and ever-present danger because burrowing animals occasionally released the water from as much as 160 acres covered to a depth of 4 to 6 in. Another factor believed to have been of material importance in preventing damage is the fact that the 6-in. slab is increased to a thickness of 9 in. at the curb.

The writer believes that the prevailing custom of constructing first-class highways well above the natural surface of the surrounding ground is good practice so long as drainage can unquestionably be handled in side ditches or by other means. Where unknown quantities of water are to be considered or where drainage waters are likely to endanger fills or even a slightly elevated sub-base, it would seem that the low grade line has certain merits that should warrant the most careful consideration.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

What Is An Engineer?

Sir—The following advertisement in the "Help Wanted—Male" columns appeared recently in a paper of this city.

> ENGINEER—LICENSED; STEAM, ELECTRICAL, HYDRAULIC POWER, ICE AND REFRIGERATION, MECHANICAL; SOBER, STEADY; GOOD REFERENCES; NO NEGRO OR DAGO DUMP NEED APPLY. ADDRESS B-109 STAR.

How many of us can qualify?

It has been reported with pride in one of the trade papers of a concern which manufactures plumbers' supplies that the term "Sanitary Engineer" is being adopted for the plumbers and that the States of Indiana, Tennessee, Minnesota and Colorado have already officially recognized this dignified title. This paper suggests that, as more fitting, the name of "Domestic Sanitary Engineer" be used, but that "all things require time."

What is there in a name anyway? It is to laugh!

WEBSTER L. BENHAM,
Consulting "Engineer" (We do sanitary work).

Kansas City, Mo., Oct. 22.

Error in Transition Curve Table

Sir—I would like to call your attention to an error I have just discovered in a paper of mine, "True Transition Curve for Railway Problems," in *Engineering News-Record*, Aug. 26, 1920. In the table for all the values of the function $T(a)$ there should be inserted another 9 between the decimal point and the first figure: e.g.

$T(a)$ for 4°30′ now reads 0.9938
it should read 0.99938

and so on.

GEORGE PAASWELL,
Consulting Engineer.

New York City, Oct. 26.

Another Method for Platting Traverses

Sir—Regarding a letter of Aug. 2 by Emile Low, commenting on a method for platting traverses explained by Herbert N. Bradstreet in *Engineering News-Record*, July 28, 1921, I wish to submit the following as involving fewer operations than either of these methods and at the same time minimizing certain sources of error.

Protractors stamped on transparent parchment are easily obtained. These may be used directly, or blue prints, on very thin paper, may be made from them and the parchment put away for future use.

First lay out a meridian and on this orient and gum or tack down the thin protractor. Now instead of pricking off and numbering the various bearings, which are two unnecessary operations and which involve most of the error in such work, lay the parallel ruler or triangle, as preferred, on the protractor and bring its edge to coincide with the given course, the center of the protractor and the course in the opposite quadrant, then transfer it and plat it in its proper place, without permitting the operation to get cold.

This not only gives a longer base than is used when the pricking off method is applied but is also an excellent guard against laying out the wrong course for if the selection of the direct course is incorrect it becomes conspicuous when the reverse course is sought for in the opposite quadrant.

In this way the working sheet will be kept clean, there will be no temporary penciling such as angle numbers, Meridian lines or deflection angles at or through every point, a feature which is of considerable advantage especially when there is a mass of detail which has to go on the sheet.

I prefer a well-made rolling parallel rule, which, when used in connection with a long light straight edge, will not only take care of any position on the board, but is much faster and probably more accurate than triangles.

This method, though more rapid and involving fewer sources of error than either of the methods referred to above, is consistent only with such field work as is usually done by stadia of rapid chaining and cannot, by any means, take the place of a system of computed co-ordinates, where computed co-ordinates are appropriately used.

New York City, Sept. 7. G. T. WHELTON,

Possibilities in Fused Cement

Sir—The article by Mr. Eckel on "Quick Hardening Cement Developed by the French," *Engineering News-Record*, Oct. 6, p. 566, calls to the attention of the engineering public of this country a product which is, as he states "certainly worth more attention than has been given to it heretofore." Abroad this material has during the past several years received considerable attention, as evidenced by the paper of Endell, entitled "Cement Rich in Alumina," read before the 1919 meeting of the Portland Cement Association, and an article by Bied dealing with the use of this material in reinforced concrete, published in "Revue de l'Ingenieur," 27-191. I have also called attention to some of the work along this line, which has been done by the Bureau of Standards, in a paper presented before the American Society for Testing Materials, in 1919. It is now being issued by the Bureau as Technologic Paper No. 197, in this form giving complete data obtained in testing a series of cements of this type manufactured by the Bureau. The tests extended over a period of five years and showed the results obtained by using the cement both as a mortar and a concrete, under various conditions of storage.

In every way the tests fulfilled the results which have been obtained abroad, with the sole exception that it was not found satisfactory to use any in concrete which would be subjected continuously to water. As a cement for reinforced concrete they would have much to justify their use over portland cement on account of the very rapid hardening, which as Mr. Eckel states, in twenty-four hours gives results which are rarely obtained with portland cement under twenty-eight days.

The French refer to this cement as fused cement, and call particular attention to its being made in a blast furnace. Our results would lead us to believe that this procedure is not one that has been used because it would give a particularly good cement, but rather one caused by manufacturing conditions. A reference to the work of Rankin, which is the fundamental work in all portland cement investigation, would reveal the fact that a mixture of alumina, lime, and silica of the composition cited by Mr. Eckel, and apparently used by the Lafarge company, will fuse at a temperature of about 1,380 deg. This temperature is about 50 deg. lower than that used in this country in portland cement clinkering. In the Bureau's work but one difficulty was encountered, namely, preventing the material from fusing. A rotary kiln was used in which it was thought desirable to produce a clinker instead of a fused product, on account of the greater ease of reducing a clinker to a ground product. The control required under these latter conditions is far more exacting than would have been required to have fused the mix, especially when compositions approaching that used by the Lafarge company were used.

There is no question about the many remarkable qualities which this cement has. So far as its production in this country is concerned, however, it is largely a matter of source of raw material. If alumina in any form would be available in large quantities near a market where such cement could be used, it would be found possible to produce these cements in an ordinary portland cement plant without any changes whatsoever.

It would be very befitting that this product should be manufactured in this country, as undoubtedly attention was first called to it by the work of Messrs. Spackmann and Lazell.

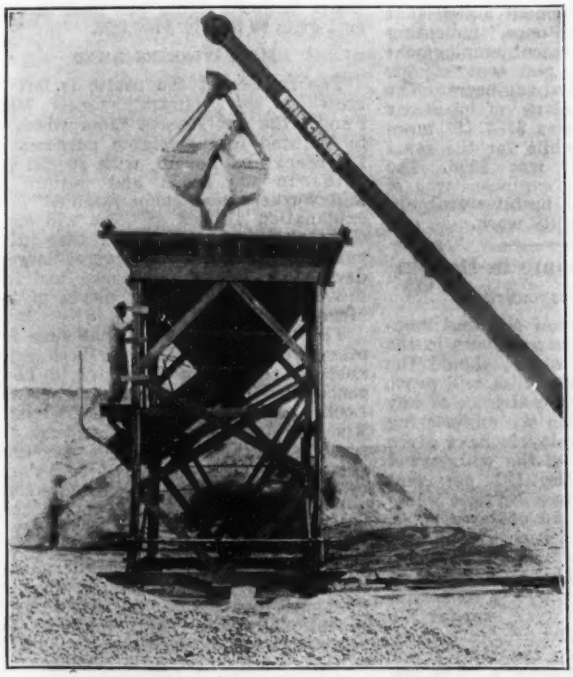
P. H. BATES,
Washington, D. C., Oct. 26. U. S. Bureau of Standards.

HINTS FOR THE CONTRACTOR

Simple Loading Hopper Proportions Aggregates from Stock Pile

TWO-COMPARTMENT trucks are loaded with proportioned batches of sand and gravel by means of the elevated hopper illustrated as installed on a 28-mile concrete road job near Garden City, Kan. The hopper has a sand and a gravel compartment and both have gates into the measuring chute. This holds the aggregate for one batch and is filled and discharged twice for a two-compartment truck. After the sand and gravel is chuted into the truck, it is driven to the cement pile where five bags of cement are poured on top of the sand and gravel. When it is windy or stormy the cement is carried in bags to the paver, where it is deposited directly into the charging skip.

From twelve to fifteen 2½-ton, two-compartment trucks take the materials to the pavers. Two cars of



PROPORTIONING HOPPER FOR CHARGING MOTOR TRUCKS

cement a day are used. Because of the fast handling of materials and sufficient water supply it is common to get large daily yardages. On June 24, according to the Chain Belt Co., which has furnished this information, the peak was reached, when 818 lin.-ft. of concrete, 16 ft. wide and 7-8-7 in. thick, were put down in 8 hr. 15 min. This record was made with a 1-min. mixing time and 10 sec. for handling, making a total of 1 min. 10 sec. per batch. Steel forms and a finishing machine were used. The contractors were the Ammerman Contracting Co., Garden City, Kan.

Steam Shovel Digs for Dragline in Hard, Stiff Material

WHEN a dragline bucket would not dig into the hard yellow and blue clay on a sewer excavation job in Detroit the contractor conceived the idea of using a heavy steam shovel to do the digging. A pit had previously been excavated along the line of the

STEAM SHOVEL AND DRAGLINE IN OPERATION ON DETROIT SEWER JOB

sewer trench and into this pit was placed a 20-ton steam shovel—weighing about 25 tons with continuous tread type of mounting. A large locomotive crane picked up the shovel and placed it in the cut.

The sewer cut is 16 ft. wide and varies in depth from 24 to 27 ft. The shovel, after its installation in the cut, loaded the material on a bench straight ahead, 15 ft. above the bottom of the cut. The dragline then swung its bucket into the bench and removed the loose material as shown in the accompanying view. Working in this way an average output of 350 cu.yd. per day was maintained with about 400 cu.yd. as the best day's work. The speed of the dragline governed the amount that could be dug.

The contractor who did the work is the Gass-Thurston Co. of Detroit. The foregoing information is supplied by the Ball Engine Co., whose type B Erie steam shovel was used in the pit to break up the clay for the dragline.

NEWS OF THE WEEK

New York, November 3, 1921

Hydraulic-Dam Core Exposed by Slope Washout

Summit Pool Overflow Cuts 15-ft. Trench in Face of Miami Conservancy Structure

Overflow of the summit pool of the nearly completed Englewood dam of the Miami Conservancy District, 10 miles northwest of Dayton, Ohio, during the night of Oct. 25 to 26, cut a narrow trench 15 ft. deep into the upstream slope of the dam and exposed the upper part of the clay core. The core material was washed out for 40 to 50 ft. along the axis of the dam and 15 ft. deep, but the exposed ends of the core remained as nearly vertical banks, with only slight sagging of the top surface for a few feet back from the edge. About 7,000 cu.yd. were washed out; of this amount not more than 800 cu.yd. were core.

As seen by a representative of *Engineering News-Record*, just after the accident, the dam, which will be 125 ft. high and is now within 15 ft. of crest elevation, has a present top width of only about 60 ft., and affords scant room for the retaining dikes required along the edges to confine the discharge of the hydraulic pumps. The entire embankment is being built by hydraulic filling, the discharge from the pipe lines along the edges of the top forming gravel and sand beaches sloping down to the central pool in which the fine materials deposit and build up the core.

Core Nearly Completed

According to H. S. R. McCurdy, division engineer at Englewood, the core was to be carried only a few feet higher, after which a central discharge pipe was to be used for bringing in the topping-out material, permitting substantial dikes to be built. At the time of the accident the dikes, formed of beach material cast up by a small dragline, were small sharpcrested levees about 5 ft. wide by 2 ft. high. The pool, about 2 ft. deep by 4,000 ft. long, contained some 150,000 cu.ft. of water. Seepage through the dike, unnoticed in the night, is believed to have caused the dike to slump and thus allowed the pool to overflow down the slope, in spite of regular inspection of the dikes by a watchman. The flow of nearly a million gallons of water down the bank trenched it in a V-shaped gully, running out about 50 ft. below the top.

Filling of the trench will require two or three weeks, but the summit work will continue at the same time over the rest of the dam, and it is expected that the final topping out of the dam, about Dec. 15, will not be delayed. Charles H. Paul, chief engineer of the district, states that the accident revealed a gratifying rapid consolidation of the core material. It had been thought that directly below the pool water a layer of several feet of the clay was semi-fluid, but this appears not to be the case, for even the immediate bottom of the pool showed no disturbance by the outflowing water. A fuller technical report of the incident is soon to be made public.

Engineering Employment Improving

The outlook for engineering services was slightly better for September, according to records of the American Association of Engineers. Not as many men registered for employment as in August while nearly as many vacancies were received and more men were placed during the month. The accompanying table shows the trend:

	Sept. 1921	Aug. 1921	Sept. 1920
Applicants for employment..	1749	2320	1372
Positions received	348	360	779
Men referred..	1861	2250	3697
Men placed....	213	204	309

Fifty-five per cent of the men who registered for employment stated that they could report "at once," indicating unemployment or present employment terminating. Forty per cent of the registrations were civil engineers. The average monthly salary of positions filled in September was $184 ($3 more than last month), while for the same month last year it was $206. The greatest demand for engineers was in highway engineering, architectural, appraisal and public utility work.

Engineering Dispute in Britain

(London Correspondence)

Hard on the heels of the coal stoppage in Britain comes a dispute in the engineering trades, which, should the threatened strike materialize, will prove just as ruinous. In the absence of any agreement being made the engineering and shipbuilding employers have given notice to their men of the withdrawal from Oct. 12 of the 12½ per cent bonus on total earnings for time workers and the 7½ per cent on piece rates. The general effect of such a reduction will be to reduce wages of 3,000,000 skilled and unskilled men from 10s. to 9s. a week, which follows a somewhat recent cut of 6s. per week. So far the employees have refused arbitration and the unions are urging the Minister of Labor to institute an inquiry. The employers will not order a lock-out unless the unions withdraw the labor, but they are resolved that these cuts shall take place since neither industry can pay the present high wages.

General Goethals Completes Lake Dallas Survey

Gen. George W. Goethals who went to Dallas, Texas, in the capacity of a consulting engineer to consider the proposal of damming the Trinity River has finished his survey and returned to New York City. The work upon which Gen. Goethals has been engaged is known as the Lake Dallas project.

Hiram F. Mills Made Notable Public Bequests

$200,000 to Harvard for Cancer Study—Gifts to Schools and Societies—Residue to City Charities

Among the numerous bequests in the will of the late Hiram F. Mills, hydraulic engineer and sanitarian (see obituary in these columns, Oct. 13) is one of $200,000 to Harvard University, the income from which is to be used in "the investigation of the origin and cure of cancer," the gift to be a memorial to Mrs. Mills. Gifts to other colleges and to technical and professional societies are: Rensselaer Polytechnic Institute and Massachusetts Institute of Technology, $10,000 each; American Society of Civil Engineers, $2,000; New England Water Works Association and Boston Society of Civil Engineers, $1,000 each; American Academy of Arts and Sciences, $5,000. Other bequests bring the total of specific gifts to nearly $450,000.

Mill Workers Aided

The residue of the estate is left in trust as the "Hiram Francis Mills Fund," the net income from which is to be used for charitable purposes in Lawrence and Lowell, with special regard "to the needs and welfare of mill workers and their families." In explanation of this gift the will mentions the fact that more than fifty years of Mr. Mills' life were "largely devoted to the maintenance and improvement of the water power of the Merrimac River."

The will also provides that since for many years Mr. Mills had been engineer of the Essex Company in Lawrence and of the Proprietors of the Locks and Canals on the Merrimac River in Lowell, the allotment by the trustees of the income from this fund for use in each city shall be subject to approval of the companies' directors.

It appears that Mr. Mills' fortune was amassed by himself, except for a small inheritance from his father, and that it was due to his business capacity, savings, and the increases in value of judicious investments, all through an exceptionally long life. When he became engineer of the Essex Co., nearly a half century ago, he conditioned acceptance of the position on the transfer to him of a stated number of shares of stock. His long connection with the company named and the similar company at Lowell, and the many friends he made not only in those organizations but also among the manufacturers and business men in the Merrimac valley enabled him to invest successfully in various mill stocks, some of which paid handsome returns. An intimate acquaintance of long standing informs *Engineering News-Record* that Mr. Mills "had a very strong faith in the manufacturing interests of the Merrimac valley and a belief that money invested there would always come back four-fold."

Court Restrains Formation of Drainage District

By a recent decision in the Washington State supreme court, King County Commissioners are permanently restrained from proceeding with the formation of a drainage district which would involve the construction of nine miles of ditch along a country road and which, when it is constructed, would be an additional burden to the abutting property. The supreme court decision affirmed the decision of the King County court. The 1921 legislature passed a law giving counties the right, so far as they have power, to construct longitudinal ditches along highways. The ditch in this case, however, was found to be one which would carve a 10-ft. zone out of the highway to drain private property, and which would seriously hamper ingress and egress to the property of the plaintiffs.

Princeton Association Meets

The Princeton Engineering Association, the organization of the engineering alumni of the institution, held a smoker at Princeton, Oct. 21, in order to extend a welcome to Dr. Arthur M. Greene, Jr., who is to become dean of the engineering department of Princeton next fall. It was the first opportunity of the engineering graduates to meet the new dean.

The occasion was honored by the presence of Dr. John G. Hibben, president of the University, who explained to the assembled graduates that Dr. Greene had been selected after a most extensive survey, resulting in the conclusion that he was the man best fitted for the work.

Engineers on Connecticut Stream Pollution Commission

Appointments by the Governor of Connecticut to the new commission for the investigation of stream pollution in that state include: Caleb M. Saville, chief engineer and manager, Hartford Water Department, chairman; Robert A. Cairns, city engineer of Waterbury; Shepard B. Palmer, an engineer of Norwich; Charles E. Wheeler of Stafford, representing the oyster industry of the state; and George Kimball of New Britain and John Goss of Waterbury, representing manufacturing interests. Frank E. Healy, attorney-general, is an ex-officio member. Mr. Kimball has been made secretary of the commission.

The bill providing for the present commission abolished the Industrial Wastes Commission created a year or two ago. That commission, which was given an appropriation of $75,000, and worked in conjunction with the State Department of Health, has completed a report which is now in the hands of the printer. The new commission has no appropriation. The State Department of Health has been ordered to turn over to the new commission all of the records of stream pollution.

The work of the Industrial Wastes Commission and proposals for a substitute were the subjects of much contention in the last session of the Connecticut legislature. A proposal to give the new commission $50,000 for its work was voted down. The new commission is to report to the legislature of 1922.

Problems of City Engineer Feature A.S.M.I. Convention at Baltimore

Twenty-Seventh Annual Meeting Considers Paving Practice and Wide Range of Municipal Subjects—E. S. Rankin New President

In contrast to its sessions of several years ago the 27th annual convention of the American Society for Municipal Improvements, held at Baltimore, Oct. 25-28, developed hardly a ripple of discord in the consideration of changes in paving specifications. As a matter of fact, no radical revisions were proposed, the chief differences of opinion relating to the committee's recommendation, for bituminous concrete, of only one mineral aggregate grading, approximating that of the expired Warren bitulithic patent, instead of alternate forms including practically a run of-crusher product. In the brick paving specifications the committee's proposal to limit the blocks to the lug type was met with opposition from the manufacturers, who urged that provision be made also for a straight-faced brick; a decision in this matter will be held over until next year.

With only one or two exceptions, the papers and committee reports developed practically no discussion, a condition explainable, in part, by the overloading of the technical program with more papers than could be disposed of effectively and failure to set any time limit on the speakers. One paper followed another in steady succession, unrelieved by discussion from the floor. The lax control of the technical program was in sharp contrast to the efficient handling of the entertainment features of the convention. Attendance was representative and on the final day the registration figures showed 162 active members, 78 associate members, and 279 guests, or a total of 519.

Membership and Finances — Reports by the officers of the society showed an active membership of 648, as of Oct. 1, 1921, as against 611 at the beginning of the year, a gain of 6 per cent. Receipts for the year totaled $5,702 and expenditures $5,518; last year's deficit of $1,600 has been reduced $500.

In his presidential address, R. Keith Compton, chairman, Baltimore Paving Commission, urged an extension of the scope of the organization by inaugurating as an annual convention feature a conference of mayors. He also recommended that the organization take steps to stimulate construction as a means of relieving unemployment, a policy which is being followed by Mayor Broening of Baltimore, who delivered the opening address.

Technical Sessions

Following the business meeting there were 6 general sessions in which the papers and reports were grouped, in so far as practicable, to cover broad subjects, such as street lighting; water supply, sewerage and sanitation; city planning and zoning; street paving methods and materials; specifications for pavements; and transportation and traffic.

Street Lighting—A committee report by C. W. Koiner, city manager, Pasadena, Cal., and papers by E. A. Anderson, National Lamp Works, Cleveland, C. A. B. Halvarson, General Electric Co., West Lynn, Mass.; and L. A. S. Wood, Westinghouse Electric & Manufacturing Co., South Bend, Ind., brought out as the most important development during the year the tendency to supersede the use of arc lights by gas-filled incandescent electric lamps of high intensity, these units running up to 1,000 cp. In fact, Mr. Anderson exhibited a 2,500-cp. unit, not yet commercially introduced. A trend, also, away from plain glassware globes to lantern type heads was noted. Mr. Halvarson described a new type of highway lighting unit, in which, by means of concentric reflectors, light beams were confined to the roadway area.

Water-works — The report of the committee on water-works presented by Nicholas S. Hill, Jr., consulting engineer, New York City, emphasized the need for employing trained men and

Reconstruction of South St. Bridge To Be Readvertised

Bids on the removal of the old South St. bridge over the Schuylkill River in Philadelphia and construction of foundations for a new bridge, as noted in these pages June 30, p. 1138, proved to be too high to be acceptable, and the city is now planning to ask bids for the entire work of reconstruction. The work to be done is the replacement of the present old wrought-iron pin connected hand operated draw-bridge (built in 1878 and reinforced in 1895) by a plate-girder structure of five spans, of which the central span will be a double leaf electrically operated bascule draw, giving a 100-ft. clear channel. The length of the work is 576 ft. Foundation work is to be carried as far as possible before closing down the old bridge. Charles Frommer, acting chief engineer of the Bureau of Surveys, Department of Public Works, Philadelphia, is in charge.

Engineering Building Planned for San Francisco

Plans are under way for interesting a large number of engineers of San Francisco in an enterprise for constructing and operating a 20- to 25-story office building which would serve as a center of engineering activity. The movement is fostered by the San Francisco Electrical Development League which estimates the cost of the project at about $2,000,000. Several schemes for financing have been considered, the preferred means being to accept the offer of a capitalist who has agreed to advance $1,700,000 toward the total amount necessary provided 1,500 San Francisco engineers will buy stock in the enterprise to the extent of $200 each. An alternative plan is to accept an offer of capitalists to meet the entire cost of construction, provided engineering societies, the Engineers' Club, and a representative number of other engineering interests agree to become tenants so the building would be assured of being a center of engineering activity.

paying them adequate salaries, if plants are to be managed efficiently. A scientific basis of rate-making and a uniform system of accounting, in order to make possible comparisons of different plants, were urged. Opportunities for substantial economies are possible, the report stated, in the standardization of water-works fittings, particularly brass goods for service connections. The centrifugal pump was characterized as the most important present pump development in the water-works field. A wider maintenance of rainfall and run-off records was recommended. The report, in predicting that a period of more active construction is rapidly approaching, sounded the following optimistic note:

"Work on the new Providence supply has been resumed, large purification projects are under way in Baltimore, Milwaukee, Cambridge, Kansas City and Detroit, while in general, the undone work of war time is only awaiting a stabilized labor market for its doing."

A description of Baltimore's water-works system by J. W. Armstrong and V. B. Siems closed the water-supply session. It was stated that tentative plans for a new filtration plant at Baltimore have been prepared.

Utilizing Sewage Sludge

Sewerage and Sanitation — Disposal of sludge formed the principal subject of the reports of the general committee and sub-committees on sewerage and sanitation, T. Chalkley Hatton, Milwaukee Sewerage Commission, chairman. The desirability of studies of methods for utilizing the fertilizing value of sewage sludge was pointed out, culminating in the passage of a resolution, by the society, calling upon the Bureau of Soils, U. S. Department of Agriculture, to undertake research work along this line. England, according to Mr. Hatton, who has just returned from that country, has made no progress in sludge disposal since 1907. The field for American effort, he said, is wide. In a sub-committee report, Langdon Pearse, Chicago Drainage District, advocated the formation of metropolitan districts, including a number of municipalities, for purposes of water supply, sewerage, lighting, garbage disposal, etc. Operating results of the Rochester (N. Y.) sewage works were presented by N. Adelbert Brown, engineer-in-charge, while John F. Skinner, principal assistant engineer, Rochester, N. Y., presented, as a portion of a sub-committee report, a careful and logically arranged analysis of the factors entering into the design of sewage-works.

City Planning — Baltimore is on the eve of drafting a zoning ordinance; the advantages of a topographical map, in this connection, were explained by J. C. Grinnalds, assistant engineer, City Plan Commission, Baltimore. Among the other papers were committee reports on local subdivisions by Nelson P. Lewis, of New York, and on zoning by Joseph W. Shirley, chief engineer, Topographical Survey Commission, Baltimore.

Paving Practice—The general report of the committee on street paving, by W. A. Howell, chief engineer, Bureau of Paving, Newark, N. J., noted a trend toward asphalt or bituminous surfaces for residential streets in cities and advocated an enlargement of municipal paving programs as a means of furnishing employment to labor.

In his report on the experimental wood block paving laid in Minneapolis in 1906, Ellis R. Dutton announced that the results indicated the following order of preference for wood: (1) Long leaf yellow pine and white birch; (2) tamarack; (3) Norway pine; (4) Western larch.

Describing the co-operative investigation which has been undertaken by the U. S. Bureau of Public Roads to correct the shoving of asphalt pavements, Prevost Hubbard, of the Asphalt Association, stated that the formation of transverse waves is most prevalent near the gutters of streets where most of the horse-drawn and slow moving motor traffic travels. "While it is possibly true," the report stated, "that the impact of fast moving traffic will accelerate shoving, once started, or may be directly responsible where irregularities in contour first existed, comparatively slow-moving, heavily loaded vehicles are believed to be the predominating cause." A. W. Dow, consulting engineer, New York, in discussing the foregoing paper, asserted that the presence of moisture coming up through the base to a point of contact with the asphalt surfacing is the most prolific cause of shoving. Another contributory factor, he pointed out, is the crushing of the binder course.

The economical extent of asphalt pavement repairs and maintenance formed the subject of an exhaustive paper by George H. Norton, city engineer, Buffalo, N. Y., which was very favorably received. It was based on the complete records which Buffalo has kept of all repair costs on asphalt pavements for about 40 years, covering about 75,000,000 yard-years of maintenance after guarantee on which the yard rate was kept separately for about 800 different contracts.

A strong endorsement of the practice of inspecting at their source materials which enter into the construction of bituminous surfaces was made by George Cobb, of Baltimore. At the asphalt plant, he said, the inspector should devote most of his time to watching the asphalt buckets, to insure proper proportioning of the materials. Papers on "Oil Asphalt" by H. Spencer, of the Standard Oil Co., and "The Real Value of Highway Literature" by Charles E. Murphy, of The Texas Co., completed the session on paving.

Specifications

Nothing important developed in the consideration of proposed changes in the society's standard specifications. The present sheet asphalt specifications, according to Herman H. Smith, committee chairman, are too lengthy and are being completely revised. Col. J. W. Howard urged the adoption of standard tests for asphaltic cement to serve as a criterion of their value, irrespective of the source from which the material comes.

As noted in the first paragraph of this report, the committee on bituminous pavement specifications recommended the discontinuance, in the case of bituminous concrete, of the provisions for a grading involving one product of crusher plant and for the Warren Co's. bitulithic pavement, the basic patent for which has expired, and the continuance of a single specification for asphaltic concrete in which the grading of the mineral aggregate is similar to that of the old Warren specifications. Prof. Arthur H. Blanchard objected to the elimination of the grading based on a single product of a stone crushing plant. The specifications as revised to carry only the one grading will go out to letter ballot.

In the committee hearings on brick pavement the manufacturers urged the adoption of a plain-faced brick, although the committee sentiment favored only a lug type. This matter will be held over for another year.

Traffic and Transportation

The committee on traffic and transportation, Prof. Arthur H. Blanchard, chairman, recommended the use of "dummy cops" at street inter-sections, rotary traffic where practicable, long-radius curb corners, and bypass highways for towns and cities on trunk routes. The committee condemned the "wild cat" jitney service in competition with street railways lines. The committee also recommended that a highway transport division be installed in engineering or highway departments of cities having a population of over 100,000. In the discussion, the trackless trolley in large cities was characterized by Prof. Blanchard as an uneconomic development. He believes that there will be a wide utilization of motor truck lines for freight service installed and operated by the railways.

The principal feature of the final session of the convention was an illustrated paper on "Subways for City Transportation" by Robert Ridgway, chief engineer, New York Transit Commission; an abstract will appear in an early issue.

Dean A. N. Johnson, of the University of Maryland, urged engineers to take a more active part in public affairs and pointed out that the engineering college is under obligation to broaden its courses of instruction the better to prepare young men to enter the public service.

New Officers

The society elected the following officers:

President, Edward S. Rankin, engineer-in-charge, Bureau of Sewers, Newark, N. J.; first vice-president, W. W. Horner, principal assistant chief engineer, sewers and paving, St. Louis, Mo.; second vice-president, Ellis R. Dutton, assistant city engineer, Minneapolis; third vice-president, H. H. Smith, deputy chief engineer, Board of Estimate and Apportionment, New York City; secretary, Charles Carroll Brown, engineer, Department of Public Works, St. Petersburg, Fla.; treasurer, Linn White, chief engineer, South Park Commission, Chicago.

Cleveland was selected as the city for next year's convention.

The local committee of the society, under the guidance of Ezra B. Whitman, consulting engineer, chairman, and Gustav J. Requardt, assistant chairman, provided an exceptionally well-arranged program of entertainment, including a dance at the Baltimore Country Club, an inspection, by special boat of Baltimore harbor, a Press Club entertainment and an automobile tour covering the city's paving operations and parks.

Abstracts of some of the convention papers and reports will appear in an early issue.

Senator Townsend Makes Statement on Road Bill

Federal Duty To Assist Interstate Highways Recognized For First Time, He Says

(*Washington Correspondence*)

The House of Representatives Nov. 1, approved the conference report on the highway bill. The test of strength came on a motion to recommit offered by Representative Hudspeth of Texas. The vote was 253 to 36. The principal opposition came from representatives of Texas and other states that are precluded by their constitutions from issuing bonds for internal improvements. Approval of the conference report by the Senate is assured, although some further delay may be occasioned. At the request of the Washington correspondent of *Engineering News-Record*, Senator Townsend prepared the following statement:

"The proposed federal road act, which is now certain to become a law, is in my judgment the most progressive step ever taken by Congress in aid of good roads.

"Representing a sentiment which favored a change in existing law to the end that a real federal purpose might be served with federal money—I proposed that a system of roads should be laid out of which the principle interstate highways should be the backbone through all of the states—highways connecting at state lines. These roads would serve from 60 to 85 per cent of the highway traffic of the states. Upon this system, and until it was completed, I proposed that all of the federal money should be expended.

GENERAL PRINCIPLES

"In the bill which has just passed the Congress, I did not obtain all that I had hoped for. I was, perhaps, asking too much, considering the organized forces against a proposition which had so little of selfish interests to serve. The new law, however, contains as its fundamentals the general principles for which I have contended. Before any state can participate in federal aid it must lay out a system of roads approved by the Secretary of Agriculture, consisting of not more than 7 per cent of the road mileage of the state; 3/7 of that 7 per cent shall be inter-state mileage, connecting with similar roads in adjacent States, and 4/7 shall inter-county roads, connecting with the inter-state highways. Sixty per cent of the states share of the federal money will be spent upon inter-state roads until they are completed, and with the consent of the state highway department, all of this money may be spent on these highways. Thus for the first time do we have a recognition by the federal government of the principle that it is the first duty of the government to assist in building its primary, or inter-state roads.

"The law also provides that the states which accept federal aid must accept it on the condition that they shall provide, from whatever source they can, the money to match the federal money. They must also provide the means for maintaining the roads built with federal aid.

"Every provision for safe-guarding the federal appropriation against waste in the construction and maintenance of durable types of road which it was possible to obtain has been incorporated in the new law. A proper administration of the act can be had, for there is ample power conferred to secure approximately the objects which the friends of good roads desire."

Rock Crusher Repair Parts Shipped by Airplane

At 8:30 one morning a telephone call was received by the Allis-Chalmers Manufacturing Co., Milwaukee, from the Lutz Stone Co., Oshkosh, Wisconsin, stating that its rock-crushing plant was closed down due to the need of repair parts. The parts being in stock, Mr. Lutz said he would call for them within an hour. This was somewhat of a surprise as Oshkosh is more than 3 hours distant by train. According to his request, however, the parts were delivered to the Milwaukee Air Port, 7 miles from the Allis-Chalmers plant, within 45 min. after the call was received. Mr. Lutz called for the parts in his airplane, and upon reaching home was able to have his plant in operation shortly after noon.

Over 2,000,000 Hp. Approved by Federal Power Commission

Since March 1, 1921, the Federal Power Commission has authorized the issuance of thirty licenses involving 1,269,000 hp. and twenty-four preliminary permits involving 1,280,000 hp., a total of 2,549,000 hp. It has already taken final action upon one-third of the applications filed. Several of the applications approved under the Act involve projects for the construction of which specific congressional authority was sought for many years, but never obtained. Notable among these are projects on the Niagara, on the Connecticut River at Enfield Rapids, and on the Coosa River in Alabama. Notwithstanding the industrial depression and the uncertain financial situation, projects aggregating 1,277,000 hp. and an investment of approximately $100,000,000 are already under construction in New York, Alabama, Wisconsin, Oregon and California.

Up to Oct. 8, 1921, there have been filed with the commission 256 applications involving over 16,000,000 hp. of which about 10,500,000 hp. is primary power and 5,500,000 secondary power. The great majority of these applications contemplate the development and sale of power as public utilities. The reports of the Bureau of the Census for 1917 showed an aggregate water-power development in the United States in that year of about seven million horsepower. The total today is probably between eight and nine million horsepower, or approximately one-half the amount represented by the applications before the commission. In 1917 there were only 259 water-power stations of a capacity in excess of 1,000 hp. engaged in the public utility service, with an aggregate capacity of 4,000,000 hp. The average investment in plant and equipment of these stations was $240 per hp. If the average investment required in the projects before the Commission is only one-half as much, an expenditure of $2,900,000,000 will be involved. The collateral expenditures for distribution systems, for customers' installation, and in accessory industries will be several times greater.

Build 97-Ft. Concrete Arch in One Month

Steel Bridge Wrecked By Colliding Autos Replaced By Concrete Structure In 25 Days.

On Sept. 21 a steel truss bridge in Maryland was wrecked by two colliding automobiles; on Oct. 22 a new 97-ft. reinforced-concrete arch was opened at the site to take the place of the bridge destroyed. At the request of *Engineering News-Record*, John N. Mackall, chairman, State Roads Commission, has sent the following story of the rapid replacement work:

"On the Washington Boulevard, running from Baltimore to Washington, over the Little Patuxent river near Savage, there was a pin connected steel bridge 101-ft. long with a height of about 18 ft. and a driveway of 13 ft. The bridge was posted on each side 'One Way Bridge,' but, despite this, a 5-ton truck loaded with asphalt tried to pass a runabout on the bridge, with the result that the two sideswiped, and the truck was thrown through the side of the bridge, and knocked out a number of the vertical and diagonal members, after which, of course, the bridge settled down in the river. The automobile hung on one of the abutments, and the truck was not badly damaged, because it went down with the bridge and did not have a long fall. This was on Sept. 21.

AWARD OF CONTRACT

"The State Roads Commission, in session on the 22nd, authorized the chairman to enter into a contract for the rebuilding of a new reinforced-concrete arch at this point. Plans were prepared and three bids received on the 24th. The contract was awarded to the Luten Bridge Co., at York, Pa., at their bid of $19,000, to be completed within 30 working days. The new bridge has a span of 97 ft. and a rise of 18 ft. and is built of reinforced concrete.

"On Monday, Sept. 26, the construction company began work with a force of men excavating for each abutment and another force erecting forms, so that on Oct. 6, the two abutments were poured, and on Oct. 10, the pouring of the arch rings started, and was completed on the 12th. The first spandrel wall was concreted on the 15th, the second was started on the 17th, back filling was started on the 19th, and on Oct. 22 at noon, traffic was turned over the bridge. On Sunday, Oct. 23, the macadam roadway was laid and the road opened for the entire width of 24 ft.

"When it is considered that the bridge was 97 ft. long and 18 ft. high, the contract price of $19,000 was not excessive even for a bridge built under ordinary conditions of approximately six months time from the award of the contract to its completion. Of course, the supporting forms remained under the arch ring, and the spandrel walls remained braced on the outside. The work of constructing the parapets will continue and perhaps the entire bridge will be completed in two more weeks."

The Engineers' Club of the Lehigh Valley met at Drown Hall, Lehigh University, Bethlehem, Pa., Oct. 25, to hear E. J. Mehren, editor of *Engineering News-Record*, speak on "Engineering and Economic Conditions in Europe."

Railroad Strike Called Off

Following a four-hour joint conference the executive committees of the "Big Five" transportation unions on Oct. 27 adopted a resolution canceling the strike call set for Oct. 30. In accordance with the resolution, a code order was sent out from the headquarters in Cleveland withdrawing the strike order. After the leaders of the conductors, engineers, switchmen, trainmen, and firemen had taken their action, officials of the railroad telegraphers organization announced they would follow suit. These constituted the only unions which had authorized a strike.

The belief on the part of the unions that a strike would be in direct contravention to the wishes of the federal government, as expressed through the United States Railroad Labor Board, was responsible for recalling the strike order. The vote not to strike was unconditional.

Tie Standardization Conference Held in Washington

Rules covering the standardization of grades and sizes, and the inspection of wood, cross and switch ties are to be drawn up as a result of a tie standardization conference held in Washington, Oct. 25. The conference was called by the American Engineering Standards Committee, at the request of the American Railway Engineering Association. Recommendations made at the conference included one that the United States Forest Service and the American Railway Engineering Association be appointed as sponsors to organize a sectional committee. Producers and consumers are to be represented on the committee which is to be directly responsible for the preparation of the standards. The rules thus standardized will be presented to the American Engineering Standards Committee with the recommandation that they be adopted. Organization of a bureau of inspection will be necessary, but it was decided to leave that step to the producers and consumers.

The conference was presided over by A. A. Stevenson, chairman of the American Engineering Standards Committee. Representatives of ten organizations directly interested in tie standardization attended the conference.

Road Congress Dues Advanced

From Jan. 1, 1922, the annual fee for individual membership in the Permanent International Association of Road Congresses will be increased from 10 to 20 francs. On July 1, 1921, the sum to be paid in order to become a life member was increased from 125 francs to 200 francs. The fee for corporate membership in the association is 100 francs, the corporation having the right to be represented in the association and at congress by as many delegates as it subscribes multiples of 100 francs. However, libraries, schools, etc., which, without paying the minimum subscription which gives the right to a delegate, desire nevertheless to receive copies of the publications of the association, may obtain them by an annual payment of 50 francs.

According to the report of the treasurer on June 10, 1921, total funds in hand amounted to 515,183 francs.

To Hold Ohio Conference on Water Filter Plant Operation

The State Department of Health of Ohio has called a conference, to be held in Columbus, Nov. 21-22, at the Southern Hotel, at which it is expected that every water purification plant in the state will be represented. An invitation has been extended to mayors, directors of public service, and superintendents of water-works to attend the conference as guests.

Engineering Societies

Calendar

Annual Meetings

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Meeting, New York City, Nov. 8-19.

CITY MANAGERS ASSOCIATION, Spartanburg, S. C.; Annual Meeting, Chicago, Nov. 14-16.

NATIONAL MUNICIPAL LEAGUE, New York City; Annual Meeting, Chicago, Nov. 16-18.

AMERICAN ROAD BUILDERS ASSOCIATION, New York; Annual Convention and Good Roads Show, Chicago, Jan. 17-20.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-19.

The New York Sections, Am. Soc. C. E., A. S. M. E., A. I. M. M. E. and A. I. E. E., will hold a joint meeting, Nov. 14, in the Engineering Societies' Building, New York City. The subject will be "The St. Lawrence Ship Channel and Power Project," and the speakers will be Governor Henry J. Allen of Kansas, W. L. Harding, former Governor of Iowa, Dr. R. S. MacElwee, director of the School of Foreign Service, Georgetown University, Washington, D. C. and H. I. Harriman of Boston.

The New England Water Works Association will have as a feature of the opening monthly meeting at Boston, Nov. 9, a paper on "Steam Boilers," by F. W. Dean. Nominations for the ensuing year include, beside a number of present officials: president, Frank A. Barbour, consulting engineer, Boston; vice-presidents, David A. Heffernan, superintendent water works, Milton, Mass.; Frank E. Winsor, chief engineer, Water Supply Board, Providence, R. I.; Theodore L. Bristol, president, Ansonia Water Co., Ansonia, Conn.; treasurer, Frederic I. Winslow, division engineer, Metropolitan District Commission, Framingham, Mass.

National Municipal League—The twenty-seventh annual meeting of the League will be held at Chicago, Nov. 16-18. Some of the sessions will be held jointly with the American Civic Association, the City Managers' Association, and the National Association of Civic Secretaries. The morning of Wednesday, Nov. 16, will be devoted to a discussion of "The Financial Plight of Our Cities—What Shall We Tax?" This session will be opened by the report of the Committee on Sources of Revenue, Luther H. Gulick, chairman, who will take up possible new sources of revenue. Municipal tax limits will also be discussed. After a joint luncheon with the City Managers' Association at the City Club of Chicago Wednesday afternoon, Nov. 16, there will be a discussion of "Is City Manager Government Applicable to Our Largest Cities?" Among those scheduled to discuss this subject are Henry M. Waite, formerly city manager of Dayton, Ohio, and Prof. Chas. E. Merriam, of the University of Chicago. Mr. Waite will deliver his address as president of the National Municipal League after an informal banquet at the City Club, Wednesday evening, Nov. 16. Among the other subjects to come before the convention will be "The High Cost of Housing" and "Zoning," each of which will have a session on the afternoon and evening of Nov. 17. The secretary of the League is H. W. Dodds, 261 Broadway, New York City.

Society of Terminal Engineers—On Nov. 15 at the Engineering Societies Building, New York City, there will be presented a paper by Nathan C. Johnson, consulting engineer, New York City, entitled "Subaqueous Concrete." Arrangement has been made for an extensive discussion by engineers interested in the subject.

Personal Notes

HENRY S. COWELL, recently with the Champion Fibre Co., Canton, N. C., as designing engineer, has opened an office in Charlotte, N. C. to engage in the practice of structural and consulting engineer.

PROF. THEODORE H. TRAMS has joined the engineering faculty of Valparaiso University. He is a graduate in civil engineering of the University of Illinois, 1907, and for two years after graduation, was a member of the faculty of the Missouri School of Mines. In 1913 he became assistant city engineer of Lewiston, Mont. Lately he has engaged in general engineering practice.

R. A. THOMPSON, has resigned as a member of the engineering board, Interstate Commerce Commission, in charge of the Pacific District, Bureau of Valuation, San Francisco, and has been appointed chief engineer in charge of construction of dams and the irrigation system of the Wichita County Water Improvement District, Wichita Falls, Tex.

H. J. KESNER has been appointed associate professor of civil engineering at Armour Institute of Technology, Chicago, Ill.

V. A. ZEHR, consulting engineer, Pekin, Ill., returned from a business trip to Europe, Oct. 17.

JACOB H. BRILLHART, has resigned as chief and consulting engineer for the Mosher Manufacturing Co., Dallas, Tex. to open an office in Dallas as consulting engineer. He will specialize in the design of steel and reinforced concrete bridges, industrial and power plant layouts, and buildings of all types.

R. H. BENNETT, formerly assistant engineer with the United Fruit Co., on railway construction in Honduras, Central America, has accepted a position as resident engineer with the Illinois Division of Highways.

THE TOPEKA ENGINEERING CORP., Topeka, Kan., has been organized to engage in general engineering practice, with Irvin Pribble as president and general manager, Ralph H. Gaw, vice-president and J. C. Marlett, secretary-treasurer.

PROF. H. S. JACOBY, for 31 years a member of the faculty of the engineering college of Cornell University and for the past 21 years professor and head of the department of bridge engineering, will retire from active duty at the close of the present college year, having reached the age specified for retirement.

J. L. HUGHSON has been appointed vice-president of the Robertson Construction & Engineering Co., Ltd., Niagara Falls, Ont.

E. V. DEVERAL has joined the staff of Barber, Wynne-Roberts & Seymour, consulting engineers, Toronto, Ont.

F. P. SHEARWOOD, who has been in the employ of the Dominion Bridge Co., Ltd., since 1887, has been appointed chief engineer of this company.

CLARENCE McN. STEEVES, recently in government employ, has joined the staff of D. C. Burpee & Son, contractors for the sub-structure of the International bridge across the St. John River between Edmunston, N. B. and Madaeaska, Me.

DR. LIVINGSTON FARRAND, for five years president of the University of Colorado, was inaugurated, Oct. 20, as president of Cornell University, Ithaca, N. Y.

JAMES H. McGRAW, president of the McGraw-Hill Co., Inc., was elected president of the Associated Business Papers, Inc., at the annual convention of the association held in Chicago last week.

G. R. ABNEY of Beaumont, Tex., has been appointed highway engineer of Angelina County, Tex.

JACOB L. CRANE, JR., who has completed a trip through England, France, Belgium, Holland, Germany, Austria, Czechoslovakia, Switzerland and Italy, studying city planning and civic affairs, will return to the United States this month.

OBITUARY

COL. GEORGE D. SNYDER, since 1902 associated with Jacobs & Davies, consulting engineers, New York, died Oct. 21, in Jersey Shore, Pa. He was born in Williamsport, Pa., in 1866. Col. Snyder commenced his professional education with his uncle, Antes Snyder, engineer of right-of-way, Pennsylvania R.R. He served for several years in the engineering departments of the Pennsylvania R. R. and the Union Pacific R. R. In 1894 he was appointed city engineer of Williamsport, Pa., which position he filled for seven years. During his connection with Jacobs & Davies he served as principal assistant engineer on the construction of the Hudson & Manhattan R.R. system. He took part also in the development of the city subway system for the New York Municipal Ry. and made a special study of the subject of city transportation. He received the "George Stevenson" gold medal of the British Institution of Civil Engineers in 1913 for a paper on "City Passenger Transportation in the United States." He served in all ranks from private to captain in the infantry of the Pennsylvania National Guard. In the war with Spain, he took a commission with the 12th Pennsylvania Volunteer Infantry, and during part of that campaign was assistant chief engineer, Second Army Corps. In 1915 he received a commission in the Corps of Engineers, N. G. N. Y., and in 1916 went to the Mexican border with his regiment, the 22nd Engineers, N. G. N. Y. During the World War, he served with the Twenty-Seventh Division. He returned as major of his regiment and was discharged from U. S. Service in 1919, retaining his rank in the reserve. In 1920, became colonel of the 22nd Engineers. In Oct. 1920, at his own request, he was transferred to the reserve list, N. G. N. Y. He also served, after his discharge from the U. S. Army, as Secretary of the Military Affairs Committee, Engineering Council.

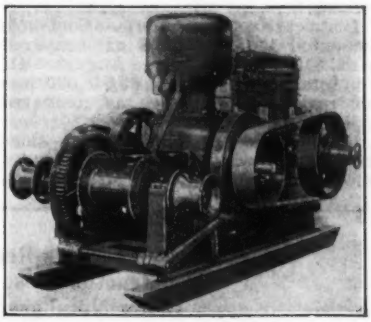
HENRY HARVIE, hydro-electric engineer, was killed Oct. 14 in the plant of the Canadian General Electric Co. at Peterborough, when a large generator burst due to an overspeed test. He was born in England and studied at London University. He came to America in 1900 and in 1901 joined the engineering staff of the Ontario Power Co. at Niagara Falls, Ont., where he spent seven years in the drafting and designing rooms. Thereafter he was employed in designing work by the Algoma Steel Corp., the Ontario Hydro-Electric Power Commission, and the Canadian Ingersoll-Rand Co., at Montreal. Last year he joined the staff of C. H. & P. H. Mitchell, Toronto.

SIR JOHN KENNEDY, consulting engineer of the Montreal Harbor Commissioners since 1907, died Oct. 25, in Montreal, Can. He was born in 1838 in Spencerville, Ont., and was educated at McGill University. From 1872 to 1875 he was chief engineer, Great Western Ry. of Canada. He was chief engineer of the Montreal Harbor Commission from 1875 to 1907 during which time he had charge of the deepening of the St. Lawrence River ship channel between Montreal and Quebec, and the enlargement of the harbor of Montreal. On Mr. Kennedy's advice, the commissioners took over the tracks of the Grand Trunk Ry., which, in 1871, had been permitted to lay a railway track on the wharf in the central part of the harbor and to have exclusive use of it, in order that the harbor should be made both a railway and ocean shipping terminal. The Montreal harbor enlargement work was commenced in 1890 and by the end of Mr. Kennedy's active administration in 1907, the development of the harbor had reached an advanced stage. In 1907, due to defective eyesight, Mr. Kennedy resigned as chief engineer, and was appointed their consulting engineer by the Montreal Harbor Commissioners, in which capacity he served until his death. His Knighthood was conferred in the honors of 1916. He was a member of the American Society of Civil Engineers and of the Institute of Engineers of Great Britain. He was one of the founders of the Canadian Society of Civil Engineers of which he was president in 1892.

EQUIPMENT AND MATERIALS

Hoist and Compressor Combined

A gasoline hoist and air compressor on one frame is now being manufactured by the Novo Engine Co., Lansing, Mich. It is designed for light steel erection, pipelaying and other operations where hoisting and riveting or caulking are accompanying processes. A 15-hp. gasoline engine operates a drum and double niggerheads by direct



gears and a 6 x 6-in. single-acting compressor by belt and pulley. The drum holds 700 ft. of ½-in. wire rope and the compressor has a displacement of 60 cu.ft. of air per minute, or enough to operate one riveting hammer. Either hoist or compressor can be operated separately as can the drum and the niggerheads. The compressor has a coolingwater tank, circulating pump, automatic unloader and all the required attachments of a self-contained compressor.

Out-of-the-Ordinary Trade Publications

The engineer who is interested in the comparative value, as measured in performance, of riveted, cast-iron and hammer-weld pipe may secure it from a recent bulletin issued by the NATIONAL TUBE COMPANY, distributors of the National hammer-weld pipe. The method of manufacturing hammer-weld pipe is described, and pictorial or other descriptions of its various uses are included in the bulletin, as well as certain hydraulic formulas and miscellaneous tables which the water supply engineer may find convenient to clip.

A veritable text book on the properties and utilization in construction of steel sheet piling is provided by the 170-page Bulletin No. 109 just published by the Lackawanna Steel Co. Sizes, properties and shapes of piles are catalogued and described. Of more interest, however, are the discussions of cofferdam design and the many descriptions of actual steel sheet piling installations dating from the period of salvaging the battleship *Maine* to the present time.

Engineers of industrial buildings and architects will find much value in the series of "Chapters" of 20 to 30 pages on the use of structural slate which are being published by the Structural Slate Co., Pen Argyl, Pa. Chapters 6, 7 and 8 on urinal stalls, shower stalls, and tubs and sinks have just been issued.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Reserve Board Finds Residential Building Increasing

In analyzing the building situation, the Federal Reserve Board, in its Nov. 1 report says: "As a whole, building continued to be well sustained during September, but improvement was evident chiefly in residential construction. All districts except No. 1 (Boston) and No. 9 (Minneapolis) showed increases in residential contracts."

District No. 1 (Boston) — Contracts amounted to $15,282,766 as compared with $19,276,295 during August. Of this total approximately $6,548,000 was for residential purposes as compared with $6,703,000 in August.

District No. 2 (New York)—Contracts awarded during September totaled $90,730,134 in comparison with $62,043,905 during August, and residential building totaled $48,789,646 as compared with $36,061,717.

District No. 3 (Philadelphia)—Contracts amounted to $16,197,500 in September and $22,350,500 in August. Residential contracts totalled $5,526,400 in September and $5,331,500 in August.

District No. 4 (Cleveland)—The total amount of contracts awarded was $36,041,601 as compared with $26,665,555 for August. Of these $8,987,610 were for residential purposes as compared with $8,209,645 during August.

District No. 5 (Richmond) — Contracts amounted to $19,597,191 in September, as compared with $17,337,624 in August, while $6,171,436 of the September total represented residential building as compared with $5,938,417 for August.

District No. 7 (Chicago) — Building contracts totaled $41,461,283 during September as compared with $44,680,034 during August.

District 9 (Minneapolis) — Building contracts amounted to $8,162,640 as compared with $9,173,552 during August.

District No. 10 (Kansas City)—Reports from 19 cities show an increase for September over September, 1920, of 71.2 per cent in the number of permits and 106.9 per cent in their valuation.

District No. 11 (Dallas) — In nine cities 2,598 permits valued at $5,680,968 were issued during September as compared with 1,864 permits valued at $3,284,841 issued during September, 1920.

District No. 12 (San Francisco) — "September building returns reached the highest point ever touched." Permits granted in 20 cities of the district number 11,169, with a valuation of $20,134,993 as compared with 9,382, with a valuation of $17,117,294, granted during September, 1920.

Engineering News-Record Construction Cost Index Number

November 1921	**166.32**
October 1921	182.57
November 1920	255.32
Peak, June, 1920	273.80
1913	100.00

Engineering News-Record's Construction Cost Index Number is 16.25 points (9 per cent) lower than last month owing to the low price of steel and numerous decreases in labor. Structural shapes in large quantities can be bought for $1.50 per 100 lb. The average labor rate for the country this month is 45c., as against 50c. last month. Lumber and cement bases remain unchanged. Thus, general construction cost is 35 per cent cheaper than one year ago and 39 per cent under the peak; it is only 66 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly	
October 1921	**109.00**
September 1921	114.00
October 1920	73.00
1913	100.00
Yearly	
1921 (10 months)	85.00
1920 (10 months)	98.00
1913	100.00

Engineering News-Record's Construction Volume Index Number is 109 for the month of October, and 85 for the whole of 1921 to date, as against 100 for 1913. This means that the actual volume of construction in 1921 (not the mere money value of the contracts let this year) is 15 per cent under the volume in the first 10 months of 1913. Our monthly volume number, 109 for October, 1921, is really the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

Southern Pine Situation Shows Improvement

Reports from the Southern Pine Association are to the effect that during the month of September the orders received averaged 129 per cent of the actual production and 106 per cent of the normal production. During the same month the shipments were 12 per cent in excess of the actual production and 91 per cent of normal production. The actual production for the month was about 82 per cent of normal production. Stocks on hand totaled 92 per cent of normal production.

For the first nine-months of this year the shipments were 104 per cent of the actual production, while during the corresponding period of 1920 shipments were but 90 per cent of production.

During the week ending Oct. 14 orders received totalled 94,472,000 ft. b. m., or 4 per cent in excess of normal production. The shipments for the same week aggregated 87,000,000 ft. b. m., while actual production amounted to 71,000,000 ft. b.m.

October Contracts Valued at $104,318,674

Sums To Be Spent On Road Work And Miscellaneous Building Are 80 Per Cent of Total

Contracts valued at $104,318,674, as reported to *Engineering News-Record*, were let throughout the United States during the month of October. Such contracts cover the construction of water works, sewers, bridges, streets and roads, excavation and dredging, industrial buildings, miscellaneous buildings, (banks, office buildings, churches, schools, theaters etc.), federal government work and miscellaneous installations. No account is taken of housing construction except that for industrial purposes, nor for residential buildings.

Of the nine classifications into which the contracts are divided, the value of contracts let for two classes of construction—street and road work and miscellaneous building—is 80 per cent of the total for the month. Contracts for public work construction and for federal government reported rather a low valuation though industrial work is quickening. Particularly is it noticeable in the number of larger industrial plants which are being constructed as compared with six months ago. The falling off in industrial work may be attributed, partially at least, to the uncertainty as to federal appropriations.

The most remarkable fact to be noted in an analysis of the contracts let for October is that the total value of miscellaneous building put under contract approximated $63,000,000. That is the largest figure recorded for miscellaneous building construction since May, 1920. For the first ten months of 1921 the total amount of money involved in the construction of bank and office buildings, lofts, churches, theatres, schools, etc., amounts to $482,000,000.

More than a quarter of a million

dollars are involved in contracts let for street and road work since the first of the year. The exact amount is in the neighborhood of $278,000,000 and is far in excess of the amount authorized for expenditure during 1920.

CONTRACTS AWARDED IN OCTOBER 1920 AND 1921

Class	1920	1921
Waterworks	$11,168,865	$899,991
Sewers	8,051,674	2,828,974
Bridges	1,573,114	1,144,810
Streets, roads	12,894,173	20,054,543
Excavation, dredging	1,086,067	372,871
Industrial	28,044,893	9,441,074
Buildings	26,385,881	62,927,041
Fed. Government	7,487,375	385,960
Miscellaneous	10,749,260	6,263,410
Total	107,441,302	104,318,674

The total value of contracts let for the past month is within 3 per cent of the total money value of contracts let during the corresponding month of 1920. However, taking into consideration the fact that there has been a decline, within the year, in the cost of construction of between 25 and 30 per cent, the actual money value of October 1921 contracts is from 22 to 27 per cent in excess of the value of contracts let during October 1920. Were the figures of the past month reduced to a basis of construction costs obtaining in October 1920, the October 1921 contracts would amount to about $132,000,000.

How's Your Business?

The Ransome Concrete Machinery Co., Dunellen, N. J., has decided to put an addition to its present plant which will increase manufacturing space 54 per cent. Ground for the building was broken Oct. 6 A. P. Robinson, sales manager, speaking for the Ransome Concrete Machinery Co., recently said:

"We have great faith in the future and our experience in the past year, despite inactivity of industrial building, causes us to feel that at least a 50 per cent increase in factory space is necessary to take care properly of the business that is being offered and which will come with the spring."

Suit in Equity Filed Against 24 Cement Firms

A suit is equity to enjoin the Midwest Cement Credit and Statistical Bureau from "keeping up an unlawful combination and conspiracy in restraint of interstate trade and commerce in cement" has been filed in the federal court in Chicago. Twenty-four firms are named as defendants. The defendants operate thirty mills in Pennsylvania, Ohio, Michigan, Indiana, Illinois, Iowa, Missouri and Kentucky.

Labor Rates and Conditions Throughout the Country

Reductions in labor rates are reported in eleven out of the twenty cities listed. Chicago, Dallas, Denver and Seattle report reductions in common labor only. Carpenters in Boston are receiving 75c. as against 90c. and common labor 40c.—as compared with 55c. per hr. formerly.

The wage scale shown for Cincinnati is effective on and after Nov. 8. Although common labor is quoted at 37½c., a minimum of 27c. per hr. is paid for common laborers on street work.

The Landis decision placed common labor at 72½c. in Chicago, but men are obtainable at 35@40c. per hour.

Denver and Dallas both quote common labor at 35c. as an average rate, with 40c. as a maximum in Denver and 45c. per hr. the maximum in Dallas.

The Associated Building Contractors of Detroit report no change in the regular scale, but individual contractors are hiring men on miscellaneous jobs for less than the regular rates. Hoisting engineers in Kansas City are receiving $1 as against $1.07½ per hour.

Los Angeles reports conditions good and very few men idle in all classes of construction work, excepting pile drivers and unskilled laborers. There is not much call for pile drivers and the rate now paid is 87½c. per hr. Not less than 30,000 men, mostly unskilled, are unemployed in Los Angeles, many having drifted in from the colder parts of the country.

The established wage scale in Minneapolis as agreed to by the unions and the employers is being cut considerably, the amounts varying on different jobs, especially as affecting carpenters, hod carriers and common laborers.

Montreal reports further adjustments in wage rates. Bricklayers are now receiving 80c. as against 85c.; hod carriers, 30@35c. as compared with 35@40c..; structural iron workers, 55c. instead of 60c. per hr. Common labor is procurable at 25@30c. per hour.

Common labor is quoted in St. Louis at 62½c., as against 67½c. formerly, and in Seattle at 50c., as against 50@60c.

San Francisco reports a reduction to $1.03 from $1.12½ per hr. for carpenters, hoisting engineers and pile drivers. Bricklayers receive $1.16, as against $1.25; hod carriers, 92c., as against $1; and common labor, 75c., as compared with 81¼c. per hour. We print the union scale for San Francisco, but unskilled, non-union labor is actually receiving 50@55c.

Labor plentiful, all classes.—Higher rates indicated by +, decreases by—

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$0.90	$0.70	$1.00	$0.30	.....	$1.00	$0.20
Baltimore	1.25	.80	.87½	.54	$0.74	1.00	.30
Birmingham	1.00	.75	.....	.25	.....	1.00	.15@.25
Boston	.90	—.75	.90	.60	.90	.90	—.40
Cincinnati	—1.12½	—.87½	.87½	—.72½	—.77½	—.77½	—.37½
Chicago	1.10	1.00	1.10	.....	.....	1.05	—.35@.40
Cleveland	1.04	1.04	1.04	.60	.91	1.04	.57½
Dallas	1.00	1.00	1.00	.60	1.00	1.00	—.35@.45
Denver	1.37½	1.00	1.00	.75@.81¼	1.00	1.00	—.35@.40
Detroit	1.00	.80	.80@.90	.50@.60	1.00	.60@.80	.50
Kansas City	1.07½	1.00	—1.00	.80	1.07½	1.07½	.70
Los Angeles	1.25	1.00	1.00	1.12½	—.87½	1.00	— 50
Minneapolis	1.00	.80	.80	.65	.....	.80	.50
Montreal	—.80	.60	.50	—.30@.35	.50	—.55	—.25@.30
New Orleans	1.00	.88	.90	.40	.80	1.00	.30
New York	1.25	1.12½	1.25	.87½	1.00	1.12½	.75
Pittsburgh	1.12½	1.00	1.00	.80	.....	1.00	Open
St. Louis	1.25	1.25	1.37½	.87½	1.25	1.25	—.62½
San Francisco	—1.16	—1.03	—1.03	—.92½	—1.03	1.16	—.50@.55
Seattle	1.00	.80	.90	.70	1.00	.80@.90	—.50

Increased Demand for Brick Tends to Equalize Prices

During September the upward tendency in the construction industry which had been reflected in previous reports has had its effect upon the price of brick according to the recent digest issued by the Common Brick Manufacturers Association of America. Predictions appearing in the digest several months ago that a stiffening of demand would show itself in equalization of prices has been realized inasmuch as the variation between the highest price and the lowest price quoted by manufacturers to the association is much less than it was a month ago. In some sections where open competition had driven the price below the cost of manufacture there are found advances in the price due to the better demand. In other sections where the price is based upon fractional production there is a lowering of the quotation due to a larger production of the plants. Altogether the digest finds that "price quotations in this issue are on a much more business-like and wholesome basis."

The railroad freight situation is found to be still the principal factor in keeping up the cost of manufacture, inasmuch as producers have to pay a large transportation cost on coal which is passed on to the consumer. In addition, the consumer pays for the high rate of delivery.

According to the digest if the general pick-up in industrial conditions continues brick men will find themselves pressed to take care of the demand when the spring season opens. The chance that fuel may become less costly, and that other elements of manufacture will be reduced, have tended to keep manufacturers who otherwise might operate during the winter from piling up stocks against the spring demand.

Trend of Business

Stock Market—Principal activity in oil stocks, as was the case the previous week. As oils are speculative, the real trend may be determined only by examining the investment groups, such as industrials and railroads. The chief feature is the professional character of the market.

Bond Market—Continued heavy demand for state and municipal issues, last week's total nearing $30,000,000, with purchases plentiful, despite rising prices. United States Government bonds closed the week strong, in sympathy with the high price commanded by municipals, with Liberty bonds from one-half to one point higher than at the close of the previous week. Railroad bonds strong, due largely to the good September showing of several railroads. Interest in public utilities seems to be increasing, as indicated by the quick sale of the Philadelphia Company's 6s. Interest in foreign government issues centers on the impending loan to China by the Consortium, which may reach $20,000,000.

Money market—Call money was 5 to 6 per cent throughout the week. Time money same as last three weeks, at 5½ per cent. Money easier throughout the country, and Government recognition of this is shown by the lowing of the interest rate on the Treasury's offering of six months' certificates at 4½ per cent, as against 5½ per cent at the end of the summer.

Foreign Exchange—Erratic, with only small changes. Sterling firm.

Little change in the market; no rise expected while note circulation increases.

About 75 per cent of the manufacturers report an outlook of "fair to good." This optimism is about equally distributed among the ten districts into which the membership of the association is divided for the purpose of the report. Every section seems to have felt something of the business revival, says the report.

On Oct. 1 the number of burnt brick on hand reported by 104 manufacturers was 205,602,000 and the orders on the books amounted to 137,644,000 brick.

Railroad Rates and Wages

According to a recent bulletin issued by the Association of Railway Executives, New York City, since 1915 there have been four general increases in freight rates which average as follows: 3.7 per cent on June 27, 1917; 2 per cent on March 15, 1918; 22 per cent on June 25, 1918; and 34 per cent on Sept. 1, 1920. This makes a total of 78 per cent. The average annual compensation of all classes of railroad employees has been increased as follows, says the bulletin: 1916, 7 per cent over 1915; 1917, 13 per cent over 1916; 1918, 41 per cent over 1917; 1919, 5 per cent over 1918; and 1920, 22 per cent over 1919. The bulletin contains this statement:

While freight rates increased the percentage stated (78 per cent) and wages were increased 119 per cent, the freight rate increase percentage is a theoretical one, while the wage increase percentage is actual. Between 1915 and 1920 the average annual compensation per employee increased from $830 to $1,820. On the other hand, with rates theortically 78 per cent higher in 1920 than in 1915, the average receipts of the railroads per ton-mile increased only from 0.722c. in 1915 to 1.052c. in 1920 or only 46 per cent.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Iron and Steel.—Structural shapes, plates and bars are quoted at the Pittsburgh mills at $1.50@$1.65 per 100 lb. Mill shipments, New York, of shapes and plates are $1.88@$2.03; bars at $1.80@$1.88 per 100 lb. Minneapolis quotes mill shipments of steel shapes at $2.51 via all rail; $2.45 per 100 lb. by lake and rail. Demand for structural material is small, due to the tendency of the buyer to anticipate a reduction in freight rates. Weaker mill prices have not as yet been reflected in the warehouse quotations. Pig-iron prices remain firm with small demand.

Railway Supplies—Heavy open-hearth steel rails have dropped $4.65 per ton; light rails 15c. per 100 lb. at Birmingham mills. Steel rails quoted in Canada at $53 per gross ton at the mill. Pittsburgh reports decrease of 70c. on standard spikes and 75c. per 100 lb. on track bolts.

Rivets and Nails—Drop of 25c. per 100 lb. on structural rivets and 15c. per keg on wire nails at Pittsburgh mill. Decrease of 10c. per keg on wire nails at San Francisco warehouses.

Pipe—Wrought-iron pipe discounts on the Pittsburgh basing card of Sept. 16 show an even increase of 5 per cent on all sizes. Cast-iron pipe advanced $2 in New York and Birmingham and $1 per net ton in Chicago. Sharp rises in sewer pipe prices again reported in St. Louis.

Road and Paving Materials—Cincinnati quotes rise of $1.61 in asphalt in packages, and $2.31 per ton in bulk. Montreal quotes drop of $5 per M. in granite paving block. Wood paving block has dropped 10c.@15c. in New Orleans and has risen 25c. per sq.yd. in Cincinnati.

Sand, Gravel and Crushed Stone—Gravel down 5c.@50c. in Chicago, St. Louis, Minneapolis, Cincinnati, San Francisco, Dallas and Atlanta; up 50c. per cu.yd. in Denver and 25c. per ton in Montreal. Sand down 10c.@50c. in Chicago, Minneapolis, Birmingham, Dallas and Denver. Crushed stone down 10c.@30c. per cu.yd. in Chicago, Cincinnati, San Francisco and St. Louis; slight advances in Kansas City and Dallas.

Lime and Cement—Hydrated finishing lime down $3.40 in San Francisco and $5 per ton in Montreal. Seattle quotes drop of 25c. in lump finishing lime and 50c. per bbl. in common lump lime. Average decline of 27c. per bbl. in cement prices in eight principal cities. Minneapolis quotes cement at $2.26 f.o.b.; $2.45 per bbl. delivered.

Brick and Hollow Tile—Common brick down 50c. in Cincinnati and up $1 per 1,000 in Atlanta. New York quotes brick at $15 wholesale as against $15@$15.50 per 1,000. Slight declines in hollow tile in Kansas City, Montreal.

Lumber—Long leaf yellow pine up $1@$4 in Cincinnati and Atlanta and down $1@$9 per M ft. in Minneapolis, Birmingham and Kansas City. Douglas fir up $1@$8 in Denver, Los Angeles and Seattle and down $1@$5 per M. ft. in Minneapolis and Kansas City. Hemlock has advanced $4 in Los Angeles and declined $1 per M. ft. in Minneapolis.

Manila Rope—Advance of 1c. reported in Los Angeles, 1½c. in Kansas City and 2c. per lb. in Cincinnati and St. Louis.

Explosives—Advance of 2c. on 40% and 60% gelatin dynamite in Kansas City and Los Angeles; decrease of 2c.@2½c. per lb. in Birmingham and St. Louis.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Current	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	$24.50†	$45.60
Northern Basic	22.52†	51.30
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	23.52†	48.50
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	30.26†	52.10
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	20.00†	42.00@45.00
PHILADELPHIA		
Eastern Pa., No. 2X, (2.25@2.75 sil.)	22.76†	51.25*
Virginia No. 2 (silicon 2.25 @ 2.75)	28.74†	50.00†
Basic	20.75†	51.00*
Grey Forge	21.75†	49.00*
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	22.70†	46.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	26.66†	50.00
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	22.96†	49.56
Basic	21.96†	48.96
Bessemer	21.96†	51.96

*F.o.b. furnace. † Delivered.

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh			
	Current	One Year Ago	Birmingham	Chicago
Standard bessemer rails	$45.00	$55.00	.....	*$38.00*
Standard openhearth rails	47.00	57.00	*$40.00*	*40.00*
Light rails, 8 to 10 lb	1.65@1.75*	2.88@4.00*	*1.60**	*1.65@1.80**
Light rails, 12 to 14 lb	1.65@1.75*	2.84@3.84*	*1.60**	*1.65@1.80**
Light rails, 25 to 45 lb	1.65@1.75*	2.75@3.75*	*1.60**	*1.65@1.80**

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In by 8 Ft. 6 In.
Chicago, White Oak	$1.35	**$1.50**
Chicago, Hardwood and Red Oak	1.20	1.30
Chicago....Empty Cell Creosoting (add'l)	.45	.50
San Francisco..... Green Douglas Fir	*.75*	*.97*
San Francisco, Empty Cell Creosoted Douglas Fir	*1.70*	*2.20*

For ties on standard "railroad administration" specifications, f.o.b. cars, St. Louis:

	White Oak	Red Oak	Pine and Sap Cypress
Grade 3	$1.15	$1.05	$0.95
Grade 2	1.05	.95	.85
Grade 1	.95	.85	.75

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Current	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	*$2.30@2.40*	$4.00@4.25	*$2.88*	$3.60	*$4.50*	4.05
Track bolts	*3.25@3.55*	6.00@6.50	*3.88*	4.60	*5.50*	4.15
Standard section angle bars	2.75	3.00@4.00	*2.88*	3.25	4.00	3.25

PIPE

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card of Sept. 16, 1921:

BUTT WELD

Inches	Steel Black	Galv.	Inches	Iron Black	Galv.
1 to 3	68½	56	¼ to 1¼	44½	29½

LAP WELD

2	61½	49	2	39½	25½
2½ to 6	65½	53	2½ to 6	42½	29½
7 to 8	62½	49	7 to 12	40½	27½
9 to 12	62½	49			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	66½	55	1 to 1½	44½	30½
2 to 3	67½	56			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	59½	48	2	40½	27½
2½ to 4	63½	52	2½ to 4	43½	31½
4½ to 6	62½	51	4½ to 6	42½	30½
7 to 8	58½	45	7 to 8	35½	23½
9 to 12	52½	39	9 to 12	30½	18½

STEEL—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	60%	60½%	56½%
3½ to 6 in. lap welded	51%	57½%	53½%

	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	46%	46%	42½%
3½ o 6 in. lap welded	37%	43%	39½%

Malleable fittings, Class B and C, from New York stock sell at list less 5% Cast iron, standard sizes, 32½% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York					
	Current	One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
4 in.	$52.30@53.30	$87.22	$40.00	$48.10@50.10	$46.20	$53.00
6 in. and over	47.30@48.30	77.22	36@38	45.10@47.10	43.20	50.00

Gas pipe and Class "A," $3 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

	New York					
Size, In.	Current	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$40.00	$62.00	$35.00	$50.00	.....	$55.00
4	50.00	77.00	85.00	60.00	$90.00	65.00
5	80.00	110.00	140.00	80.00	115.00	84.00
6	105.00	140.00	140.00	100.00	150.00	110.00
8	175.00	228.00	200.00	150.00	250.00	181.00

SEWER PIPE—The following prices are in cents per foot for carload lots:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	$0.14	.087	.....	.1175	*$0.12*	*$0.12*	.....
4	.14	.087	$0.09	**.1575**	*.12*	*.15*	$0.18
5	.21	.1305	.....	.1645	*.18*	*.18*	.165
6	.21	.1305	.135	**.225**	*.18*	*.21*	.25
8	.35	.203	.225	**.315**	*.28*	*.30*	.35
10	.52	.3045	.....	.329	*.42*	*.42*	.....
12	.67	.3915	.3825	**.441**	*.54*	*.54*	.80
15	1.15	.522	.5625	.73	*.72*	*.90*	.....
18	1.55	.725	.765	1.029	*1.00*	*1.32*	.....
20	1.98	.87	1.125	1.372	*1.20*	.....	.....
22	2.64	1.16	.....	.....	*1.60*	.....	.....
24	2.97	1.305	1.4625	**1.95**	*1.80*	*2.16*	2.40
27	4.50	1.885	.....	2.75	3.75	*3.00*	.....
30	5.00	2.088	*3.20*	3.40	4.75	*3.60*	.....
33	6.55	2.61	.....	4.05	5.50	.....	.....
36	7.50	2.9725	.....	**4.70**	6.00	.....	.....

	3	5	8	12	24	36
Boston	*$0.108*	*$0.162*	*$0.252*	*$0.486*	*$1.62*	**$4.92**
Minneapolis	.....	.....	.40	.77	2.55	5.66
Denver	.....	.15	.30	.50	1.95	.....
Seattle	.145	.....	.36	.72	2.59	.....
Los Angeles	.11*	.165*	.275	**.495**	1.65	.....
New Orleans	.....	.108	.27	.459	1.755	.....
Cincinnati	*.10*	*.15*	*.233*	*.45*	*1.50*	*4.305*
Atlanta	.098*	.147*	.245	.4165	1.5925	.....
Montreal, *delivered*	.30*	.45*	.85*	1.35	4.50	6.50
Detroit	.105	.1575	.245	.4725	2.115	5.4325
Baltimore *(f.o.b.)*	*.1225*	*.2275*	*.35*	.6885	*2.28*	*5.20*
Kansas City, Mo	.15	.21	.335	.60	2.41	4.74

*4-in., 6-in., 9-in., respectively.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

		Current	One Year Ago
New York, 45% asphalt	(at terminal)	**$0.05½**	$0.13
New York, 65% asphalt	(at terminal)	.05	.12
New York, binder	(at terminal)	**.08**	.13
New York, flux	(at terminal)	**.06½**	.13
New York, liquid asphalt	(atterminal)	.06½	.....
St. Louis, 50-60% asphalt *(f.o.b.) Tulsa, Okla.*		*.015**	.12
Chicago, 40-50% asphalt		.05	.08½
Chicago, 60-70% asphalt		.05½	.08½
Dallas, 40-50% asphalt		.10	.10
Dallas, 60-70% asphalt		.13	.13
Dallas, 75-90% asphalt		.15	.15
San Francisco, binder, per ton		15.00†	13.00

* Freight $21.75 per ton to Whiting, Ind.
† F.o.b. Oleum, Cal. Freight to San Francisco, 85c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbl. or 425-lb. drums) and in bulk in carload lots:

	Package	Bulk
New York (Bayonne, N. J.)	$28.00	$17.00
Boston	No quotations	
Chicago	25.85	19.50
San Francisco, *f.o.b. refinery*, Oleum, Cal.	21.50*	15.00*
Dallas	35.00	27.00
Seattle	27.50	21.50
Denver	45.00	65.00
Minneapolis	....	20.50
St. Louis	28.00	22.00
Baltimore	28.00	....
Los Angeles, *at factory*	22.50	15.00
Montreal	28.00	21.00
Atlanta	30.00	....
Detroit (petroleum asphalt)	24.50	20.00
Cincinnati	26.10	21.80
Maurer, N. J. (asphalt)	27@38	....
Maurer, N. J. (asphalt cement)	29@36	25@31

*Freight to San Francisco, 80c. per ton.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums. Rebates of about $1 per bbl., no rebate for drums.

PAVING STONE—

New York	5-in. granite, 28@29 blocks per sq.yd.	$125.00 per M
Chicago	About 4x8x4 dressed	3.35 sq.yd.
	About 4x8x4 common	3.00 sq.yd.
San Francisco	Basalt block 4x7x8	65.00 per M
Boston	5-in. granite	125.00 per M
Atlanta	Granite	2.00 sq.yd.
Detroit	Granite, 26½ blocks per sq.yd.	107.00 per M
Baltimore	Granite	2.15 sq.yd.
Montreal	Granite	125.00 per M
New Orleans	Granite, 4 x 8 x 4	3.25 sq.yd.
Cincinnati	Granite	4.30 sq.yd.
St. Louis	4x8x4 dressed	3.25 sq.yd.
	4x8x4 common	3.00 sq.yd.
Kansas City	No. 1 Granite	3.95 sq.yd.

FLAGGING—

New York	Bronx	$0.25	sq.ft.
	Manhattan, 4 ft.	.26	sq.ft.
	Queens, 5 ft.	.26	sq.ft.
	6x20-in. cross-walk	1.00	lin.ft.
Chicago	18 in. wide	.99	lin.ft.

CURBING—Bluestone per lineal foot, in New York, costs 77c. for 5x16 in., 88c. for 5x18 in.; in cargo lots.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.09
New York	3½	16	2.17
New York	4	16	2.37
Boston	3	16	2.17
Chicago	4	16	3.00@3.25
Chicago	3½	16	2.50@2.75
St. Louis	3½	16	3.25
St. Louis	4	16	3.75
Seattle	4	16	Off market
Minneapolis	3½	16	2.13
Atlanta	3½	16	2.30
New Orleans	3	16	2.00
New Orleans	3½	16	*2.25*
New Orleans	4	16	*2.50*
Dallas	4	18	3.90
Baltimore	3½	16	*3.60*
Montreal, *delivered*	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	4	16	2.60
Kansas City	4	16	*2.15*

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots is as follows, per cu.yd.:

	Gravel 1½ In. Current	Gravel 1½ In. One Year Ago	Gravel ¾ In. Current	Gravel ¾ In. One Year Ago	Sand Current	Sand One Year Ago
New York	$2.00	$3.00	$2.00	$3.00	$1.25	$1.50
Denver	2.50	2.00	2.50	1.80	*1.10*	1.60
Chicago	*1.65*	2.75	*1.65*	2.75	*1.65*	2.75
St. Louis, *per ton*	*1.30*	1.65	*1.25*	1.70	*1.20**	1.70
Seattle	1.50	1.25	1.50	1.25	1.50	1.25
Dallas, *delivered*	*2.25*	2.50	*2.25*	2.50	*2.25*	2.50
Minneapolis, *at pit*	*1.50*	2.00	1.50	....	*.50*	1.25
Cincinnati	*1.87½*	....	*2.03*	1.50	*1.60*	1.45
San Francisco	2.25	1.50	*2.25*	1.50	1.50	1.50
Boston, per ton	2.65	3.50	2.65	3.00	2.00	2.75
New Orleans	2.85	3.60	....	....	1.35	1.85
Los Angeles, per ton	1.35†	1.25	1.35†	1.25	1.20†	1.15
Atlanta, per ton	*2.00*	3.12	*2.00*	....	1.35	1.62
Detroit	2.00	1.85*	2.00	1.85*	2.00	1.70*
Baltimore, per ton	1.40	1.40‡	1.60	1.60‡	2.40	.70
Montreal, per ton	*1.25*	1.50‡	1.50	....	1.25	1.25‡
Birmingham, per ton (Crushed slag used instead of gravel)					*1.28*	1.25‡

* Fine white sand: Pacific, $4 per ton; Ottawa, $4.50

† Freight from quarry to Los Angeles is 70c. per ton, and is included in above price.

‡ Per cu. yd.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Current	1½ In. One Year Ago	¾ In. Current	¾ In. One Year Ago
New York	$1.80@1.90	$1.90@2.00	$1.80@1.90	$2.15
Chicago	*1.60*	2.75	*1.60*	2.75
St. Louis *delivered*	*1.55**	2.00	*1.55*	2.00
Dallas, *delivered*	3.20	2.50	3.20	2.50
San Francisco	2.25	1.50	*2.25*	1.50
Boston, *delivered*	3.00*	3.00* (del.)	3.00*	3.00* (del.)
Minneapolis, *at plant*	2.00	2.25	2.25	2.50
Kansas City	2.75	2.35	2.75	2.35
Denver	3.50	....	3.50	....
Seattle *delivered*	3.00	3.50 (del.)	3.00	3.50 (del.)
Atlanta	2.25*	3.25	2.25*	3.50
Cincinnati *delivered*	*2.37½*	....	2.08	1.65
Los Angeles	1.60*	1.60*	1.70*	1.70*
Detroit	1.90*	2.00	1.90*	2.00*
Baltimore	1.75*	1.80*	1.65*	2.20*
Montreal	2.00*	2.30*	2.10*	2.55*
Birmingham *delivered*	3.20	....	3.10	....

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Lebanon or Bethlehem, Pa.	$1.00	$1.00	$2.50	$0.90
Easton or Catasaqua, Pa.	1.00	1.00	2.00	.90
Buffalo, N. Y. and Erie, Pa.	1.25	1.25	2.25	1.25
Emporium, Pa.	1.25	1.25	....	1.25
East Canaan, Conn.	1.25	1.35	4.00	1.10
Birmingham, Ala.	.75	.95	2.05	.80
Toledo, Ohio	1.50	1.50	2.35	....
Atlanta, Ga.	....	2.10	....	....
Eastern Pennsylvania and New Jersey	1.20	1.20	2.50	.90
Western Pennsylvania and New Jersey	1.25	1.25	2.50	1.25

Birmingham, f.o.b. sidings $1.12 (or $1.45 per cu. yd. on site)

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per 180-Lb. Barrel (net) Finishing	Lump, per 180-Lb. Barrel (net) Common
New York	$16.99	....	....	$3.69*
Chicago	*18.00*	....	....	1.40
St. Louis	0.58	$0.50	$2.25	0.70†
Boston	23.00	20.00	*3.35*	3.10
Dallas	25.00	....	....	2.75
Cincinnati	0.49	0.45	....	....
San Francisco	*22.00*	*18.00*	....	1.90
Minneapolis	29.00	22.00 (white)	1.80	1.40
Denver	30.00	....	.95†	2.95
Detroit	15.25	13.25	11.50‡	10.50‡
Seattle	27.50	....	*3.25*	*2.75*
Los Angeles	....	30.00	3.00*	3.00*
Baltimore	15.00	13.00	....	12.00‡
Montreal	*21.00*	21.00	15.00‡	15.00‡
Atlanta	19.00	16.00	2.00	1.60
New Orleans	....	17.25	....	1.75

* 280-lb. barrels (net). † Per bushel. ‡ Per ton.

Minneapolis quotes brown lime; Kelly Is. white is $1.70, Sheboygan $1.60

Cincinnati and St. Louis quotes hydrated lime per 50-lb. sack.

NOTE—Refund of 10c. per barrel.

NATURAL CEMENT—Price to dealers for 500 bbl. or over, f.o.b., exclusive of bags:

	Current	One Year Ago
Minneapolis (Rosendale)	$2.80	$3.00
Kansas City (Ft. Scott)	1.60	1.60
New Orleans	3.16	3.36
Atlanta (Magnolia)	11.00 ton	1.90
Cincinnati (Utica)	*1.77*	2.85
Boston (Rosendale)	*.85@.95*	2.35

PORTLAND CEMENT—Current prices are for barrels in carload lots, *without* bags, to contractors:

	Current	One Month Ago Without Bags	One Year Ago Without Bags
New York (delivered)	$2.40	$2.50	$4.10
New York, alongside dock to dealers	2.10	2.10	
Jersey City	*2.28*	2.60	3.55
Boston	*2.61*	2.61	3.32
Chicago	*1.97*	1.97	2.35
Pittsburgh	2.22	2.02	2.42
Cleveland	2.38	2.28	2.73
Detroit	2.21	2.31	2.71
Indianapolis	2.23	2.23	2.57
Toledo	2.31	2.31	2.71
Milwaukee	2.19	2.19	2.51
Duluth	1.95	1.95	2.35
Peoria	*2.14*	2.14	2.63
Cedar Rapids	*2.28*	2.28	2.71
Davenport	*2.22*	2.22	2.67
St. Louis	*2.25*	....	....
San Francisco	2.84	2.84	3.09
New Orleans	*2.88*	3.20	4.60
Minneapolis (on cars)	2.26	2.26	2.71
Denver	3.10	3.10	3.25
Seattle	3.10	3.10	3.12
Dallas (f.o.b.)	2.55	2.55	3.85
Atlanta	*2.60*	2.69	3.75
Cincinnati	2.37	2.37	2.77
Los Angeles	3.31	3.31	3.10
Baltimore (del.)	2.88	2.88 (del.)	4.59 (del.)
Birmingham	*2.27*	2.85	....
Kansas City	*2.45*	2.80	2.76
Montreal (delivered)	3.10	3.10 (del.)	2.95 (f.o.b.)

NOTE—Bags 10c. each, 40c. per bbl.; 80c. per bbl. in Montreal; 60c. per bbl in Los Angeles.

Current mill-prices per barrel in carload lots, without bags; to contractors:

Buffington, Ind	$1.70
Pittsburgh, Pa	1.75
Steelton, Minn	1.75
Northampton, N. Y.	1.85
Hudson, N. Y.	1.95
Vulcanite, N. J.	1.85

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds	Pittsburgh, Mill	New York (Warehouse)	Chicago	Dallas	San Francisco
032	0.022	$0.74	1.13	$0.82	$1.15	$1.24
049	0.028	.94	1.40	1.05	1.46	1.56
068	0.035	1.14	1.67	1.27	1.80	1.92
093	0.045	1.46	2.11	1.63	2.30	2.46
126	0.057	1.80	2.58	2.02	2.86	3.07
153	0.068	2.14	3.05	2.40	3.40	.....
180	0.078	2.46	3.48	2.76	3.93	.....
245	0.103	3.24	4.55	3.63	5.15	.....
287	0.119	3.75	5.25	4.20	5.96	6.41
336	0.138	4.35	6.07	4.87	7.32	.....
395	0.160	5.04	7.01	5.65	8.00	.....
			PAVING			
036P	0.017	$0.56	$9.88	0.62	$0.88	.....
053P	0.024	.79	1.26	0.88	1.24	.....
072P	0.031	.99	1.48	1.11	1.57	.....
097P	0.040	1.28	1.87	1.43	2.02	.....
049R	0.024	.79	1.20	.....	1.24	.....
067R	0.031	.99	1.48	.....	1.57	.....
084R	0.040	1.28	1.87	.....	2.02	.....

Made in 16-, 20-, 24-, 28-, 32-, 36-, 40-, 44-, 48-, 52- and 56-in. width in rolls 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27	233	$23.25	$23.39	$23.39	$27.62	$25.50
26	250	24.65	24.93	.....	29.21	27.56
25	300	27.30	27.45	27.45	.....	30.71
24	340	29.10	29.33	29.33	35.73	33.16
22	433	33.80	34.06	.....	.....	35.10

* Material shipped from mill, freight allowed, or at warehouse. Delivery charge is 1c. per sq.yd.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1.65	$1.75	$2.78	$1.90	$2.87	$3.50	$3.00
⅝ and larger	1.70	1.90	2.83	1.95	2.92½	3.55	3.05
¾ and larger	1.75	1.90	2.88	2.00	2.97½	3.60	3.10
⅞ and larger	1.90	1.90	2.93	2.15	3.12½	3.75	3.25
1 and larger	2.15	1.90	2.98	2.40	3.37½	4.00	3.50

* Includes 15c charge for cutting to lengths of 2 ft. and over.
Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ and larger	$1.75	$1.90	$3.25	½	$2.00	$2.15	$3.50
⅝ in	1.80	1.95	3.30	¾	2.25	2.40	3.75
⅞	1.85	2.00	3.35		.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Current	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	$18.40	$18.40@19.40	$22.70	$47.00	$42.50
New York (at dock)	15.00	15@15.50	.....	.....	.....
Chicago	11.00	11.00	15.00	34.00	42.50
St. Louis, salmon	17.00	17.00	17.00	.....	.....
Denver, salmon	14.00	14.00	15.00	.....	.....
Dallas	12.72	12.72	25.00	44.00	.....
San Francisco	18.00	18.00	18.00	.....	44.38
Los Angeles	15.50	15.50	13.50	(not used)	
Boston (del.)	17.00	17.00	30.00	46.00	56.25
Minneapolis (del.)	17.00	17.00	24@26	.....	43.00
Kansas City	14.50	14.50	22.00	.....	.....
Seattle	14.00	14.00	19.00	48.00	53.50
Cincinnati	18.00	18.50	24.00	41.00	.....
Montreal (del.)	16.00	16.00	20.00	100.00	120.00
Detroit (del.)	17.00	17.00	20@22	41.30	44.00
Baltimore (del.)	20.00	20.00	20@25	38.00‡	.....
Atlanta	11.00	10.00	20.00	40.00	.....
New Orleans	14.00	14.00	25.50	.....	.....
Birmingham	11.50	11.50	.....	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. ‡ Vitrified, f.o.b. plant, Baltimore.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Current on Trucks*	New York: One Year Ago	Chicago	St. Louis	San Francisco	Perth Amboy N. J., Factory
4x12x12	$0.11370	$0.2444	$0.0821	$0.080	$0.108	.....
6x12x12	.15160	.3259	.1343	.115	.154	.....
8x12x12	.20210	.4345	.1575	.145	.243	$0.17810
10x12x12	.....	.....	.1853	.200	.....	.22260
12x12x12	.....	.....	.2408	.230	.....	.26720

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	$0.0965	$0.182	$0.251
Minneapolis (f.o.b. cars)	.084	.161	.230
Minneapolis (delivered)	.092	.175	.250
Cincinnati	.0682	.128	.175
Kansas City	.085	.167	.270
Denver	.09	.16	.23
Seattle	.10	.175	.30
Los Angeles factory	.103	.185	.22
New Orleans	.14	.25	.42
Detroit (delivered)	.070	.135	.225
Montreal	.15	.30	.35
Baltimore	.16	.26	.42
Atlanta	.0765	.136	.....
Dallas	.124	.....	.....
Birmingham	.095	.1785	.....

†San Francisco quotes on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh, Mill	Birmingham Mill	New York (del.)	Dallas	St. Louis	Chicago (del.)	San Francisco
Beams, 3 to 15 in.	1.65	$1.90	$2.88	$4.00	$2.97½	$2.88	$3.70
Channel, 3 to 15 in.	1.65	1.90	2.88	4.00	2.97½	2.88	3.70
Angles, 3 to 6 in., ¼ in. thick	1.65	1.90	2.88	4.00	2.97½	2.88	3.70
Tees, 3 in. and larger	1.65	1.90	2.88	4.00	2.97½	2.88	3.70
Plates	1.65	1.90	2.88	4.00	2.97½	2.88	3.70

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh, Mill	Warehouse: New York, Current	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	$2.40	$3.70	$6.11	$3.68	$3.77½	$5.50	$5.50

CONE HEAD BOILER

½ in. and larger	2.50	3.80	7.10	3.78	3.87½	5.60	5.65
⅝ and ¾	2.65	3.95	7.25	3.93	3.87½	5.75	5.80
⅞ and 1	2.90	4.20	7.50	4.28	3.87½	6.00	6.05

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in. take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.90	$3.60	$4.80	$5.00	$3.48	$4.95
Cut	3.00	6.10	6.25	7.75	4.08	5.00

PREPARED ROOFINGS—Standard grade rubbered surface, complete with nails and cement, costs per square as follows:

	New York: 1-Ply l.c.l.	New York: 2-Ply l.c.l.	New York: 3-Ply l.c.l.	Philadelphia: 1-Ply l.c.l.	Philadelphia: 2-Ply l.c.l.	Philadelphia: 3-Ply l.c.l.
No. 1 grade	$2.12	$2.48	$2.90	$2.02	$2.38	$2.80
No. 2 grade	1.87	2.18	2.55	1.77	2.08	1.67

Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.15 per roll in carload lots and $2.40 for smaller quantities f.o.b. Philadelphia.

Shingles, red and green slate finish, cost $6.15 per square in carloads; $6.40 in smaller quantities, in Philadelphia.

ROOFING MATERIALS—Prices f.o.b. New York:

Tar felt (14 lb. per square of 100 sq.ft.) per roll of 432 sq.ft.	$2.35
Tar pitch (in 400-lb. bbl.), per 100 lb.	1.85
Asphalt roofing (in barrels), per ton	47.50
Asphalt felt (light), per ton	77.00
Asphalt felt (heavy), per ton	78.50

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.50	$2.87½	$3.38	$5.50	$3.28
No. 12	2.55	2.92½	3.43	5.55	3.33
No. 14	2.60	3.97½	3.48	5.60	3.38
No. 16	2.80	3.07½	3.58	5.70	3.48
Black					
*Nos. 18 and 20	2.85	3.95	3.95	5.80	4.05
*Nos. 22 and 24	2.90	4.00	4.00	5.85	4.10
*No. 26	2.95	4.05	4.05	5.90	4.15
*No. 28	3.00	4.15	4.15	6.00	4.25
Galvanized					
No. 10	3.00	4.15	4.15	....	4.25
No. 12	3.10	4.25	4.25	5.85	4.35
No. 14	3.10	4.25	4.25	5.85	4.35
Nos. 17 to 21	3.40	4.55	4.55	6.15	4.65
Nos. 22 and 24	3.55	4.70	4.70	6.30	4.80
*Nos. 25 and 26	3.70	4.85	4.85	6.45	4.95
*No. 28	4.00	5.15	5.15	6.75	5.25

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Current	New York: One Year Ago	Chicago: Current	Chicago: One Year Ago
Raw in barrel (5 bbl. lots)	$0.72	$1.15	$0.72	$1.25

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	12.25	13.75	15.50	17.00	12.25	15.50
25 and 50-lb. kegs	12.50	14.00	15.75	17.25	12.50	15.75
12½-lb. keg	12.75	14.25	16.00	17.50	12.75	16.00
5-lb. cans	15.25	16.75	18.50	20.00	15.25	18.50
1-lb. cans	17.25	18.75	20.50	22.00	17.25	20.50

LUMBER

Prices wholesale to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in more than carload lots:

	Lumber Prices in Yards at San Francisco			
	6–8 and 12 Ft.	10–16–18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$25.00	$28.00	$31.00	$35.00
3x6 and 8	25.00	28.00	29.00	31.00
4x4-6 and 8	27.00	30.00	31.00	33.00
3x10 and 12	27.00	29.00	31.00	33.00
3x14	28.00	30.00	32.00	34.00
4x10 and 12	29.00	31.00	33.00	35.00
4x14	30.00	32.00	34.00	36.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft
6x10	$30.00	$32.00	$34.00
6x14	32.00	34.00	36.00
8x10	30.00	32.00	34.00
3x14	32.00	34.00	36.00

New York, Chicago and St. Louis

	Southern Pine			
	New York*		Chicago	
	20 Ft. and Under	20–24 Ft.	20 Ft. and Under	22–24 Ft.
3x 4 to 8x8	$35.00	$36.00	$41.00	$42.00
3x10 to 10x10	37.00	38.00	43.00	44.00
3x12 to 12x12	40.00	41.00	48.00	47.00
3x14 to 14x14	45.00	46.00	49.00	50.00
3x16 to 16x16	50.00	51.00	59.00	60.00
3x18 to 18x18	55.00	56.00	64.00	65.00
4x20 to 20x20	65.00	66.00	66.00	67.00

* Wholesale price (to dealers) of long leaf pine. Short leaf pine up to 14 x 14 costs $15 per M. less.

Price to contractors, on lighters or cars, New York, about $5 additional.

St. Louis: Yellow pine, 22@24 ft. long, 3 x 4 to 4 x 4, $34.50; 3 x 6 to 8 x 8, $33; 3 x 12 to 5 x 12, $40; 3 x 14 to 4 x 14, $46; 3 x 16 to 4 x 16, $51; 3 x 18 to 5 x 18, $58.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12x12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under. For pine add $2 to the price of merchantable for all sizes.

Other Cities

	8 x 8-In. x 20 Ft. and Under				12 x 12-In. 20 Ft. and Under	
	P.	Fir	Hemlock	Spruce	P.	Fir
Boston	$47.00	$52.00	$55.00	$48.00	$57.00	$52.00
Seattle	.....	22.00	.....	.....	.....	24.00
New Orleans	28.00	23.50	.....	.....	33.09	27.00
Baltimore	30.00	.....	.....	.....	32.50	.....
Cincinnati	42.00	50.00	.....	.....	46.00	64.00
Montreal	78.00	85.00	68.00	78.00	78.00	100.00
Los Angeles	.....	41.00	40.00	.....	.....	41.00
Denver	.....	31.25	.....	.....	50.00	38.75
Minneapolis	*40.00*	*35.00*	33.00	.....	*47.00*	*35.00*
Atlanta	29.00	.....	.....	.....	40.50	.....
Dallas	33.00	.....	.....	.....	37.00	.....
Kansas City	*33.00*	*29.50*	47.00	.....	*38.00*	*33.00*
Birmingham	*16.00*	.....	.....	.....	*22@25*	.....

	1-In. Rough, 10 In. x 16 Ft.—and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir	Hemlock	P.	Fir
Boston	$47.00	$48.00	$37.00	$45.00	$48.00
Seattle	.....	15.00	.....	.....	24.00
New Orleans, at mill	52.00	25.00	.....	32.00	.....
Baltimore	34.00	.....	.....	32.50	.....
Cincinnati	62.50	80.00	.....	33.50	.....
Montreal	120.00	60.00	60.00	80.00	80.00
Los Angeles	.....	38.00	37.00	.....	63.00
Denver	.....	30.75	.....	.....	29.25
Minneapolis	*37.50*	31.25	*29.25*	*36.00*	29.25
Atlanta	16.50	.....	.....	20.00	.....
Dallas	32.00	30.00	.....	36.00	.....
Kansas City	*36.00*	33.00	.....	*32.50*	*31.00*
Birmingham	*15.00*	.....	.....	*15.00*	.....

Montreal—Up to 32 ft.; over which, $3.00 per M. increase up to 30 ft.

Birmingham—Quotes carload lots, f.o.b. sidings. $2 additional per M. ft. for delivery.

Cincinnati—Prices to contractors in carload lots, f.o.b.

FREIGHT RATES

On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.33½	Detroit	$0.32½
Birmingham	.76½	Kansas City	.81½
Boston	.41½	New Orleans	.51½
Buffalo	.29½	New York	.38
Chicago	.38	Pacific Coast (all rail)	1.66½
Cincinnati	.325	Philadelphia	.35
Cleveland	.24	St. Louis	.47½
Denver	1.35*	St. Paul	.66½

Note—Add 3% transportation tax. * Minimum carload, 40000 lb.

Minimum carload, 50,000 lb., structural steel only; 80,000, lb. for other iron or steel products.

CONTRACTORS' SUPPLIES

STEEL SHEETPILING—The following price is base per 100 lb. f. o. b. Pittsburgh, with a comparison of a month and a year ago:

Current	One Month Ago	One Year Ago
$1.80@1.90	$2.00	$4.00@$4.50

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	New York and East of Missouri River
Hercules red strand, all constructions	25%
Patent flattened strand, special and cast steel	25%
Patent flattened strand, iron rope	10%
Plow steel round strand rope	40%
Special steel round strand rope	35%
Cast steel round strand rope	27½%
Iron strand and iron tiller	10%
Galvanized iron rigging and guy rope	+7½%

California, Oregon, Nevada and Washington: Galvanized iron rigging and guy ropes +12½%; bright plow 35% off.

Wyoming, New Mexico and Colorado: Plow steel, round strand, 35% off, galvanized iron rigging and guy rope +12½%.

Arizona: 30% plow steel; +17½% galvanized iron rigging and guy rope.

Montana, Idaho and Utah: 30% plow steel; +7½% galvanized iron rigging and guy rope.

Western territory not included in above: Plow steel, 35%; galvanized iron rigging and guy rope +12½%.

MANILA ROPE—For rope smaller than ¼-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; ⅞-in., 2 ft. 4 in. Following is price per pound for ¼-in. and larger, in 1200-ft. coils:

Boston	$0.19	New Orleans	$0.16
New York	.17½	Los Angeles	.15½
Chicago	.18	Seattle	.16
Minneapolis	.18½	St. Louis	.18½
San Francisco	.16	Montreal	.30
Atlanta	.20	Detroit	.175
Denver	.18	Baltimore	.22
Cincinnati	.19	Kansas City	.17½
Dallas	.29	Birmingham	.20½

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin	
	40%	60%
New York	0.3075	$0.3425
Boston	.24	.275
Kansas City	.26	.295
Seattle	.1875	.2125
Chicago	.2275	.2525
Minneapolis	.2274	.2530
St. Louis	*.26*	*.29*
Denver	.2350	.2700
Dallas	.29	.375
Los Angeles	.25	.29
Atlanta	.2675	.3025
Baltimore	.2550	.27
Cincinnati	.2275	.2725
Montreal	.32	.37
Birmingham, *delivered*	*.165*	*.205*
New Orleans	.2725	.3075
San Francisco	.195	.23

PILES—For plain pine piles, delivered New York, the price is as follows:

Pine 12-in. butts, 6-in. tops, length 41-50 ft.	$9.00@11.00
Pine 14-in. butts, 6-in. tops, length 51-60 ft.	18.50@15.50
Pine 14-in. butts, 6-in. tops, length 61-71 ft.	19.00@21.00

	Dallas		St. Louis
6-in. x 20-ft.	$4.60	6-in. x 30-ft.	$6.95
		7-in. x 30-ft.	8.30
6-in. x 30-ft.	7.10	7-in. x 35-ft.	11.70
		8-in. x 35-ft.	13.90
8-in. x 30-ft.	8.45	7-in. x 40-ft.	13.90
		8-in. x 45-ft.	18.70
8-in. x 35-ft.	10.38	8-in. x 50-ft.	22.10

SCRAP—The prices following are per gross ton paid to dealers and producers in New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$10.50	$11.50	$13.50
Stove plate	10.50	12.00	13.50
No. 1 machinery cast	16.50	13.50	16.00
Machine shop turnings	3.00	4.00	6.50
Cast borings	3.75	5.50	8.50
Railroad malleable cast	9.50	12.50	11.00
Re-rolling rails	11.50	13.00	12.00
Relaying rails	30.00	30.00	27.00

SHIP SPIKES—Current prices per 100 lb.:

	San Francisco		Seattle
In.	Galv.	Black	Black
⅜	$9.10	$8.40	$8.55
½	8.65	6.65	8.25
⅝	8.50	6.50	8.30

Pittsburgh base, *$3.25@$3.40* per 100 lb.